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(54) **ELECTROPHOTOGRAPHIC PHOTOSENSITIVE DRUM, PROCESS CARTRIDGE, AND ELECTROPHOTOGRAPHIC IMAGE FORMING APPARATUS**

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G03G 15/00 (2006.01)

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(58) **Field of Classification Search** 399/110, 399/111, 112, 117, 167
See application file for complete search history.

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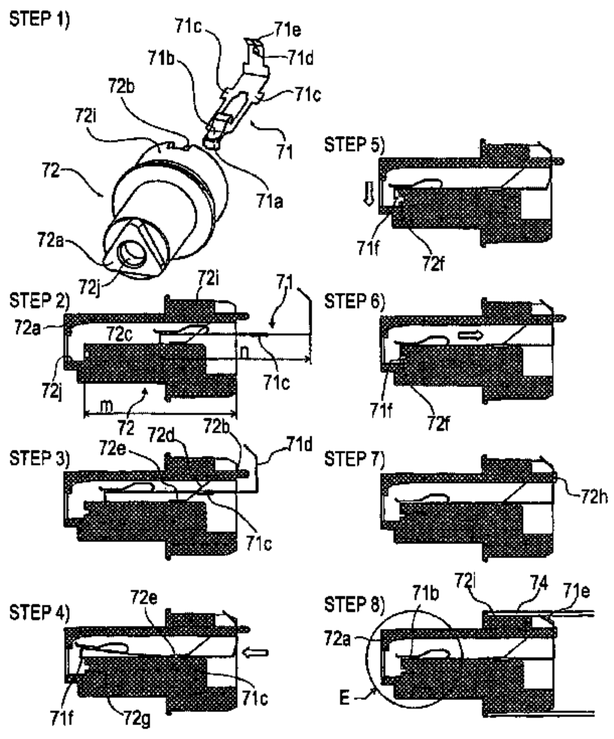
(57) **ABSTRACT**

An electrophotographic photosensitive drum includes a non-circular twisted projection, provided at one longitudinal end of the drum, having a cross-section with a plurality of corner portions, and being engageable with a non-circular twisted hole located at a central portion of a driving rotatable member of a main assembly of an image forming apparatus and has a cross-section with a plurality of corner portions; and a second electroconductive member contactable with a first electroconductive member electrically connected with the main assembly of the image forming apparatus. The first electroconductive member is disposed in the hole to ground the drum. The second electroconductive member is provided on the projection and electrically connected with the drum. The contact position between the first and second electroconductive members moves in interrelation with the projection being retracted toward the hole by rotation of the driving rotatable member when the projection is engaged with the hole.

2 Claims, 9 Drawing Sheets



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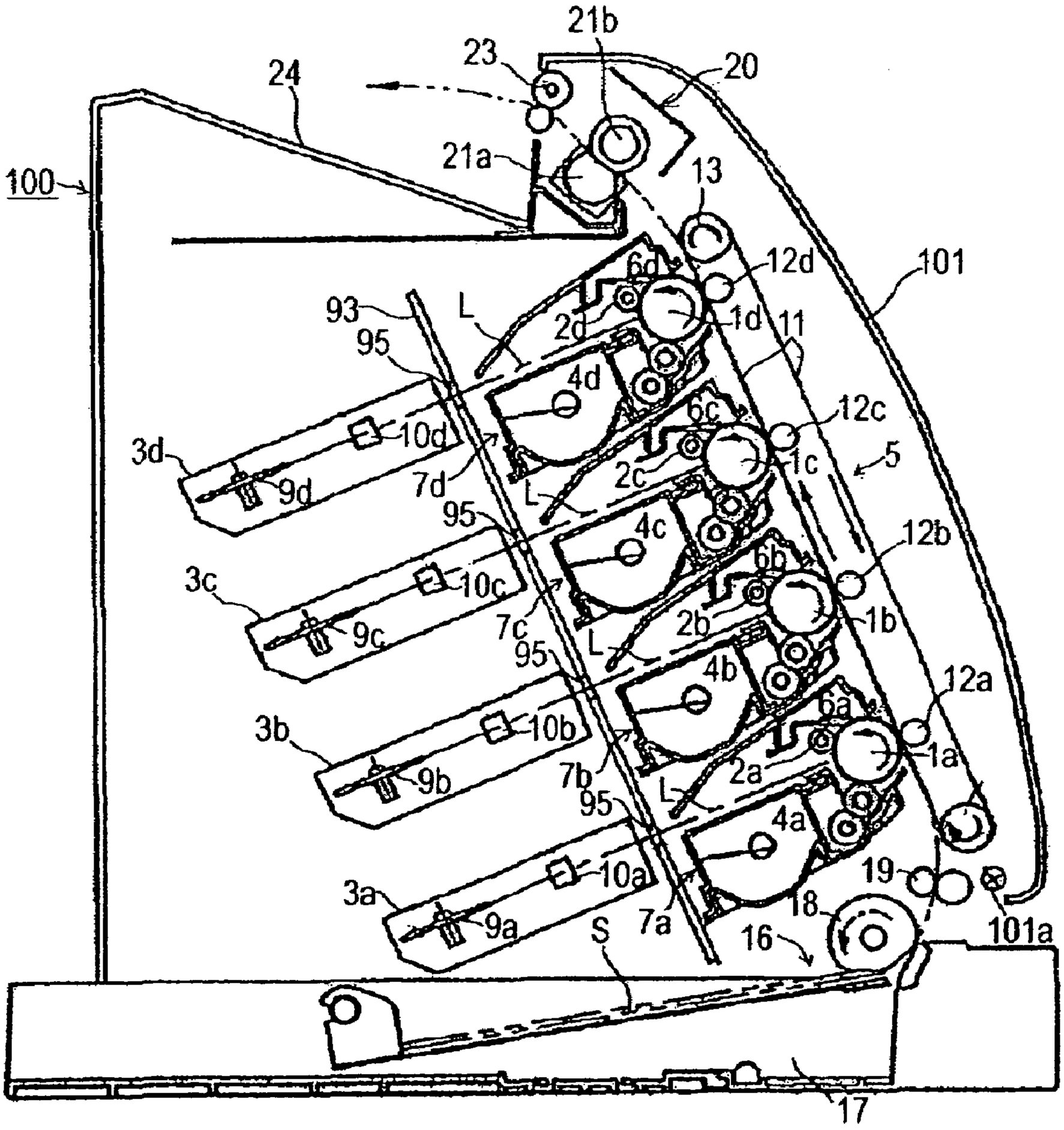
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9d
7d
6c
12c
1c
5
2c
4c
12b
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9c
7c
6b
2b
1b
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12a
10b
3b
9b
7b
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7a
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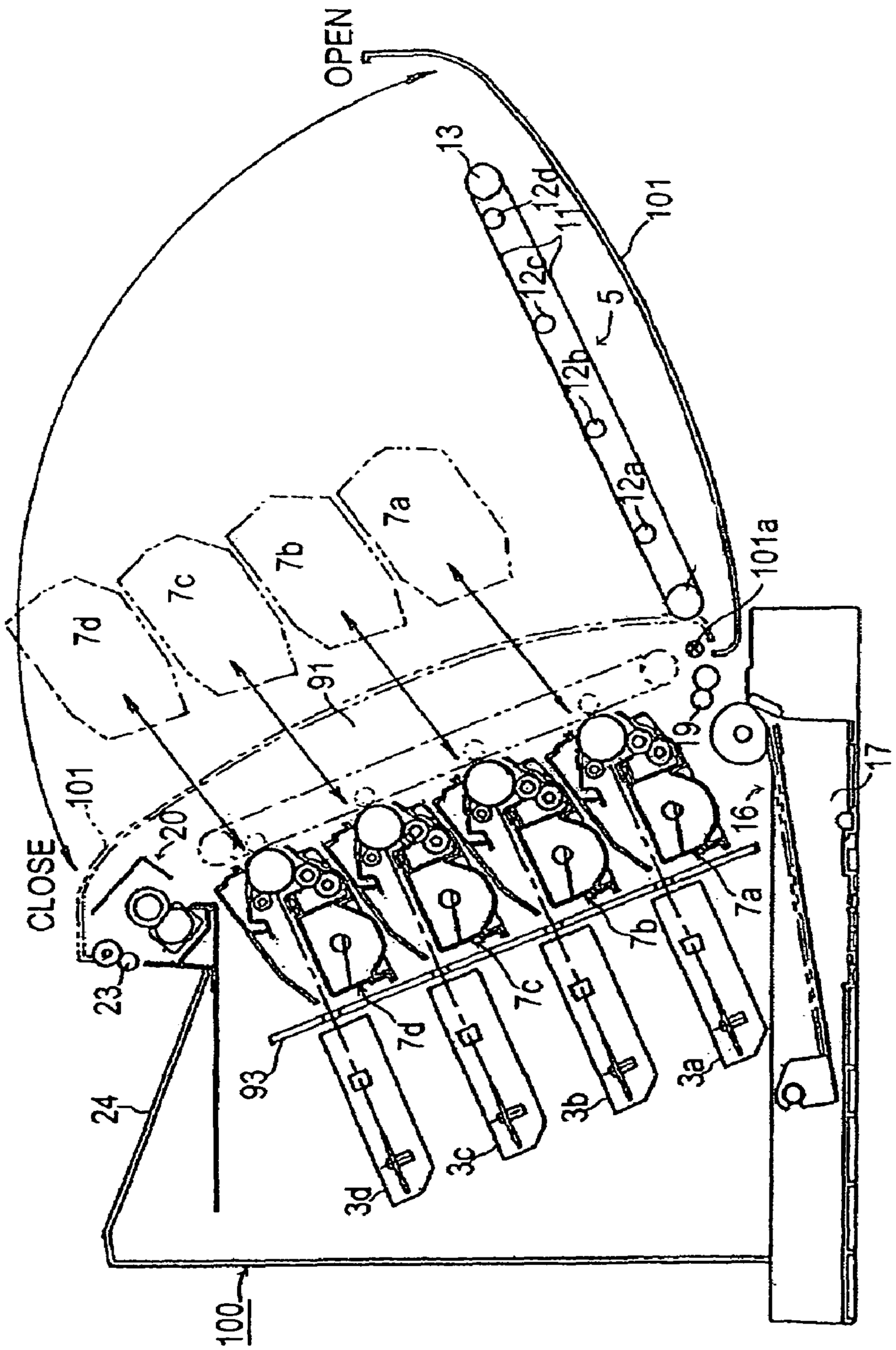
S
16
101a
17

FIG. 1


OPEN
13
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11
12c
12b
12a
101
5
101a
19
17
16
7a
7b
7c
7d
91
93
CLOSE
101
20
23
24
3a
3b
3c
3d
100

FIG.2

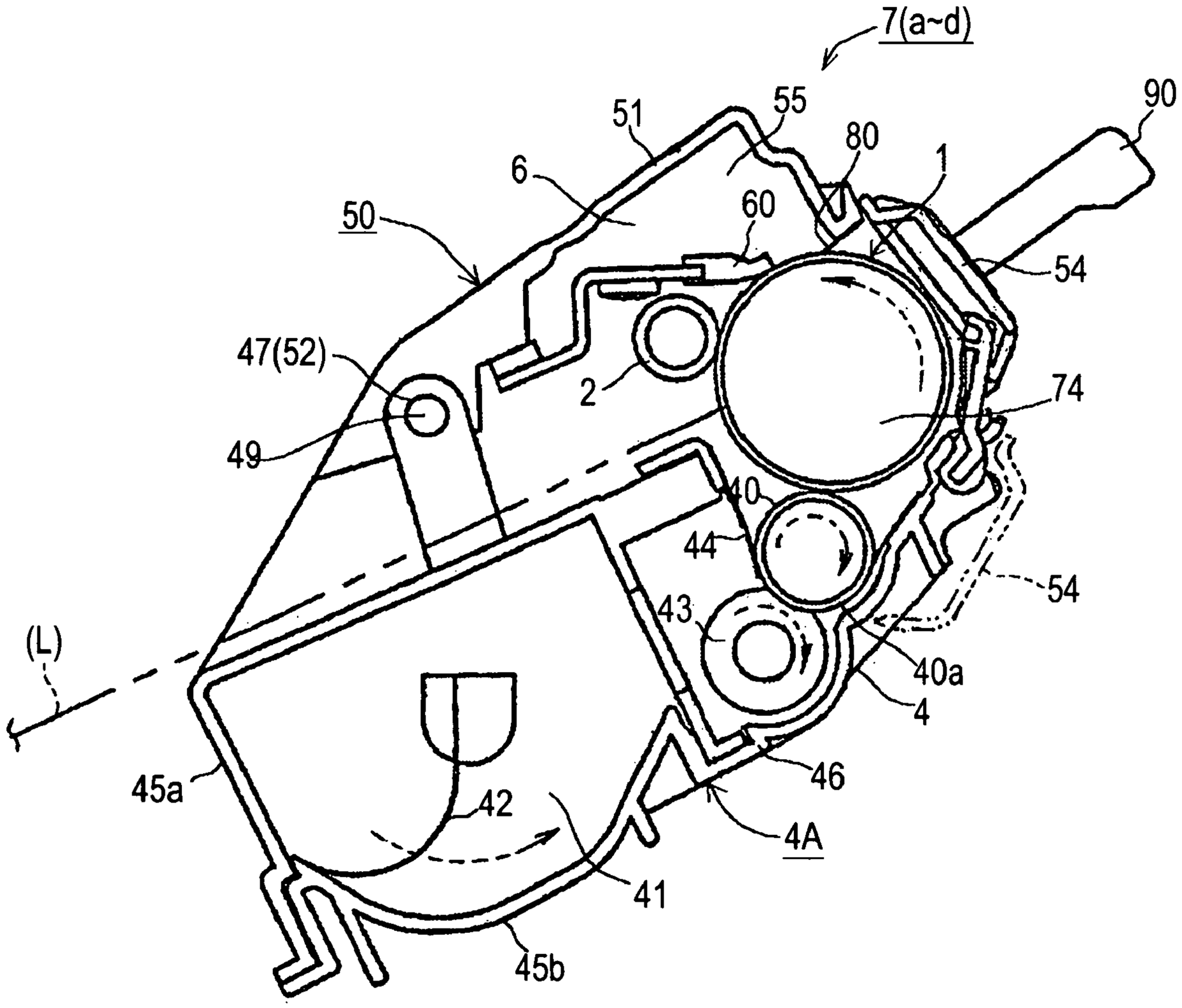

7(a~d)
51
55
90
80
1
6
60
50
54
47(52)
2
74
49
40
44
54
43
(L)
40a
4
45a
46
42
4A
41
45b

FIG.3

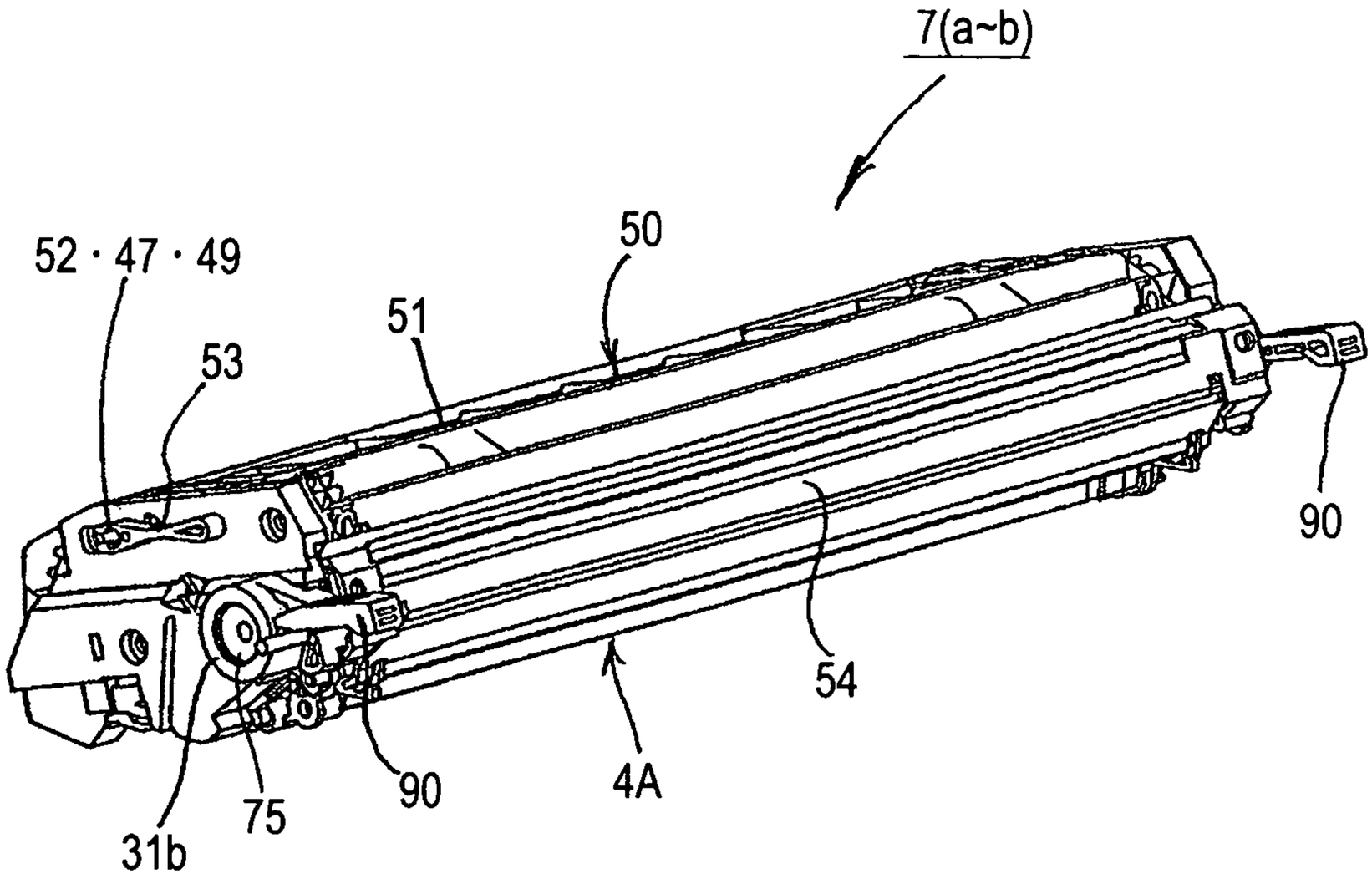

7(a~b)
50
52 · 47 · 49
51
53
90
54
4A
90
75
31b

FIG.4

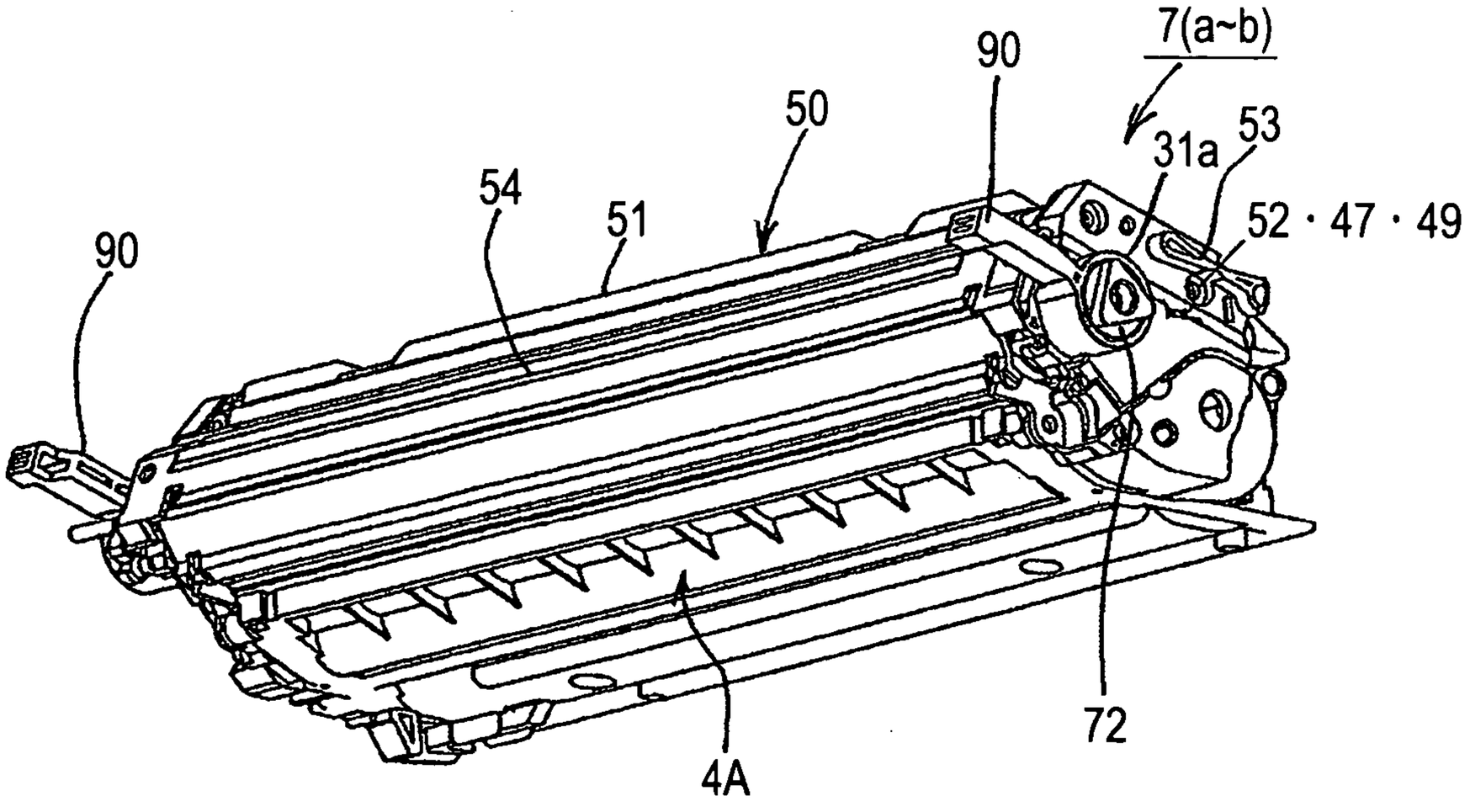
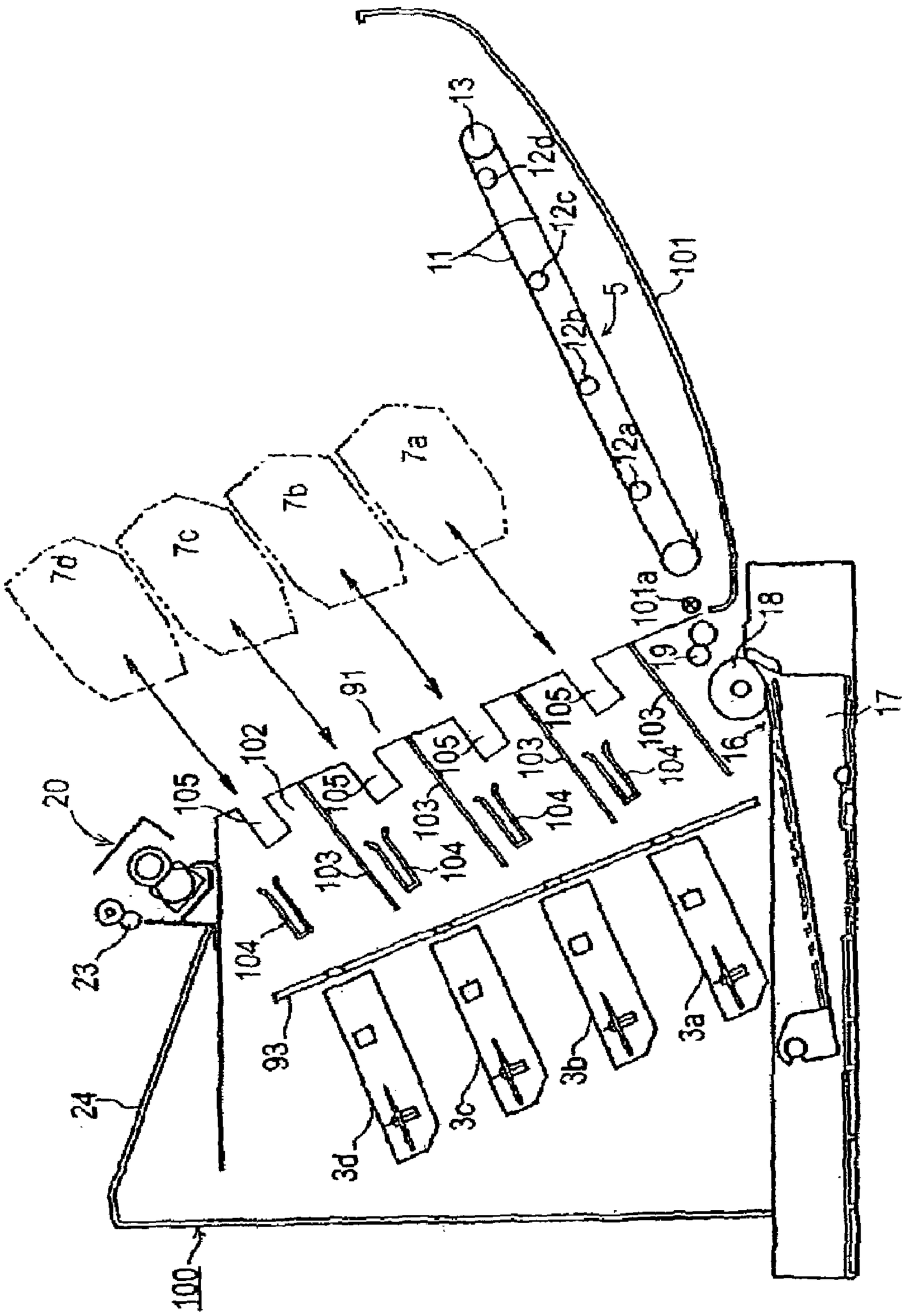

7(a~b)
90
50
31a
53
54
51
52 · 47 · 49
90
72
4A

FIG.5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11
101
5
12b
12
12a
7a
7b
7c
7d
101a
18
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91
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105
103
104
16
17
20
23
93
3a
3b
3c
3d
24
100

FIG.6

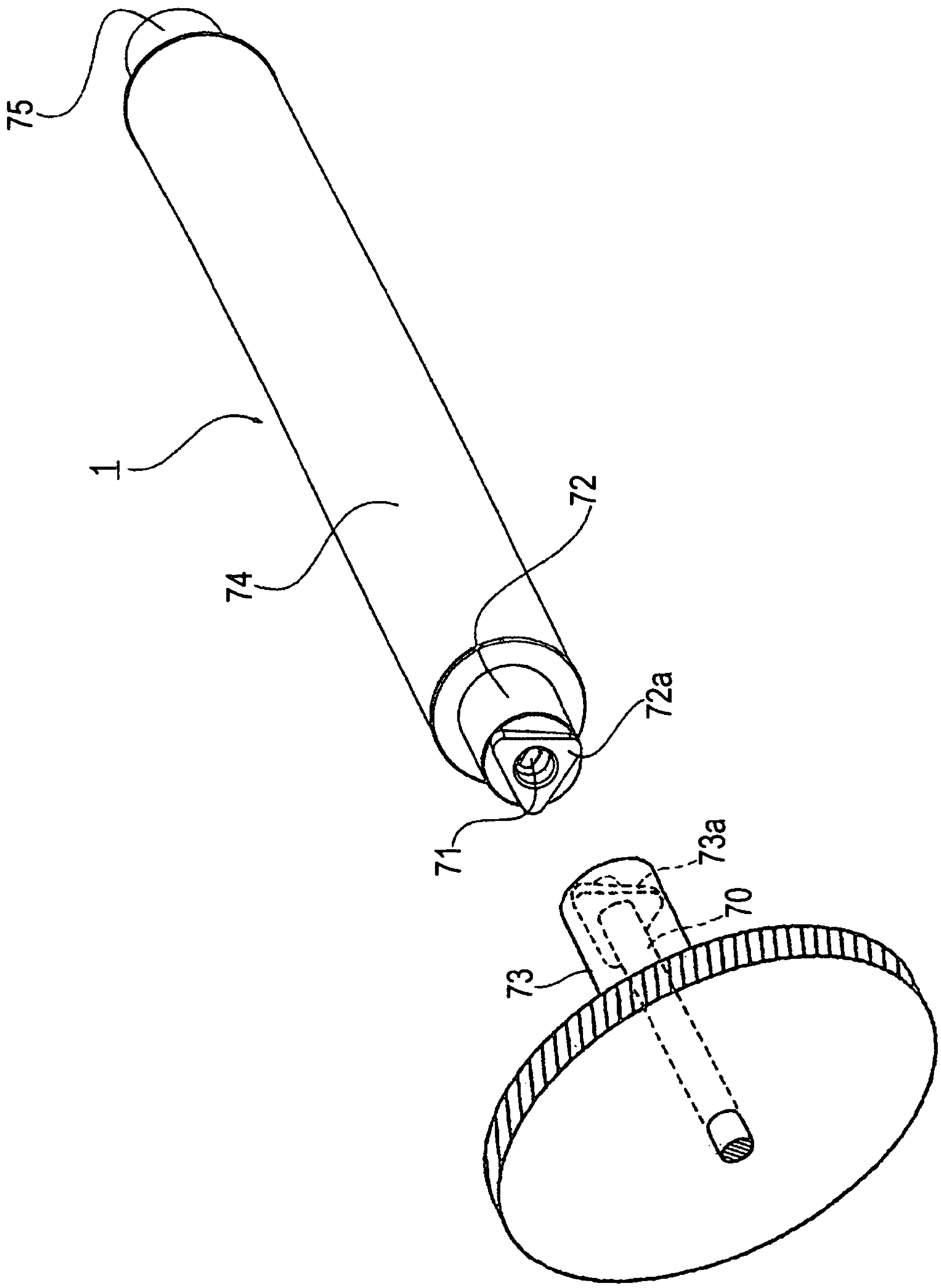
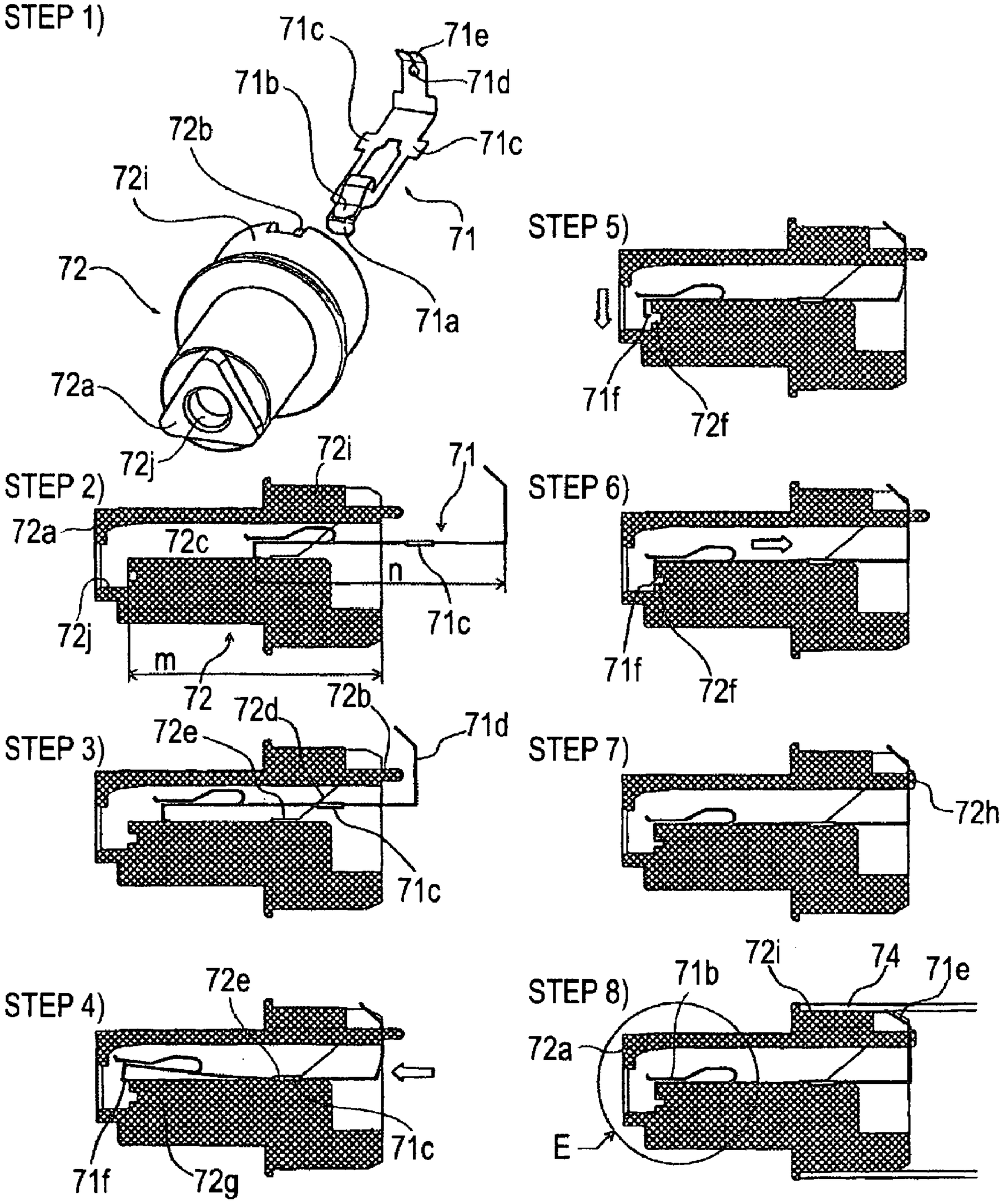


FIG. 7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71c
71e
71b
71d
72b
71c
72i
71
72
71a
72a
72j
STEP 5)
71f
72f
STEP 2)
72i
71
72a
72c
n
72j
71c
m
72
STEP 6)
71f
72f
STEP 3)
72d
72b
72e
71d
71c
STEP 7)
72h
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71c
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72g
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71b
72i
74
71e
72a
E

FIG.8

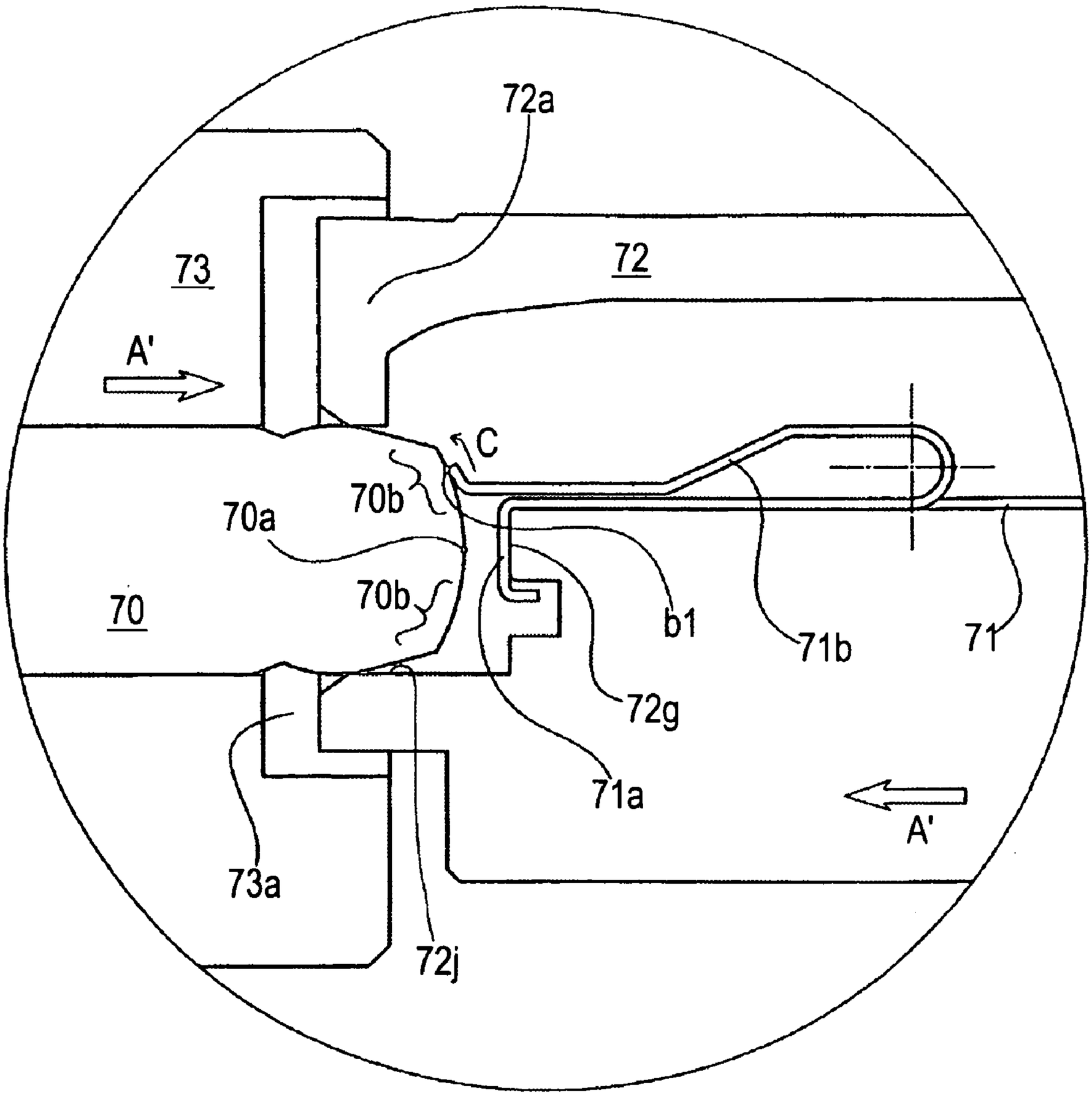


FIG.9

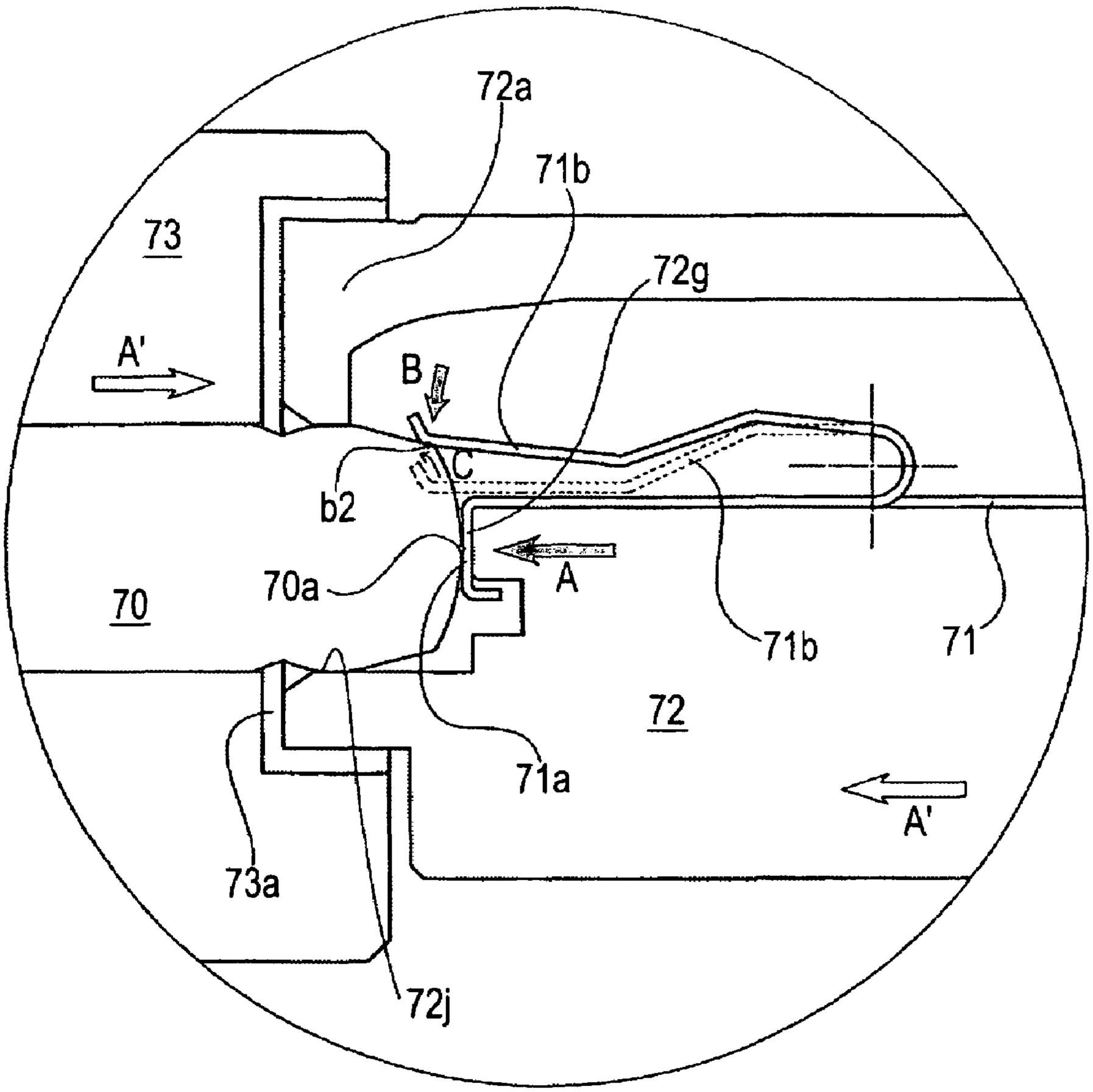


FIG. 10

ELECTROPHOTOGRAPHIC PHOTOSENSITIVE DRUM, PROCESS CARTRIDGE, AND ELECTROPHOTOGRAPHIC IMAGE FORMING APPARATUS

FIELD OF THE INVENTION AND RELATED ART

The present invention relates to an electrophotographic photosensitive drum, a process cartridge comprising an electrophotographic photosensitive drum, and an electrophotographic image forming apparatus.

Here, an electrophotographic image forming apparatus means an apparatus for forming an image on recording medium with the use of one of the electrophotographic image forming methods. The examples of an electrophotographic image forming apparatus include an electrophotographic copying machine, an electrophotographic printer (for example, a laser printer, an LED printer, etc.), a facsimile apparatus, a word processor, etc.

A process cartridge is a cartridge which is removably mountable in the main assembly of an image forming apparatus, and in which a minimum of one among a charging means, a developing means, and a cleaning means, as a processing means, and an electrophotographic photosensitive member, are integrally placed so that they can be removably mountable in the main assembly of an image forming apparatus.

A photosensitive drum unit means an electrophotographic photosensitive member in the form of a drum, employed by the main assembly of an electrophotographic image forming apparatus.

An electrophotographic image forming apparatus such as a copying machine, a laser printer, a facsimile machine, etc., forms an electrostatic latent image by selectively exposing numerous points of the peripheral surface of the electrophotographic photosensitive drum uniformly charged by a charging apparatus. Then, it develops the electrostatic latent image into a visible image (image formed of toner) by adhering toner to the electrostatic latent image, with the use of the developing apparatus, and yields a copy of an intended image by transferring the toner image onto a recording medium such as a sheet of paper. After the transfer of the toner image, it removes the toner remaining on the peripheral surface of the electrophotographic photosensitive drum, with the use of the cleaning apparatus, preparing the photosensitive drum for the following image formation operation.

In the field of an electrophotographic image forming apparatus employing an electrophotographic image formation process, it has been a common practice to employ a process cartridge system, in which an electrophotographic photosensitive drum, and a single or plurality of processing means, such as a charging apparatus, a developing apparatus, a cleaning apparatus, etc., which act on the electrophotographic photosensitive drum, are integrally placed in a cartridge removably mountable in the main assembly of an image forming apparatus. According to this process cartridge system, apparatus maintenance can be carried out by a user by himself, without the need for relying on service personnel, drastically improving an image forming apparatus in operational efficiency. Thus, a process cartridge system has been widely used in the field of an image forming apparatus.

An electrophotographic photosensitive drum is structured to allow residual electric charge to escape from the electrophotographic photosensitive drum to the main assembly of the image forming apparatus. More specifically, the electrophotographic photosensitive drum comprises a drum cylinder formed of electrically conductive substance, and a pair of flanges having a shaft portion by which the electrophotographic photosensitive drum is supported by the frame of a process cartridge or the main assembly of the image forming apparatus. The flanges are attached to the lengthwise ends of the drum cylinder by being pressed into the openings of the lengthwise ends of the drum cylinder. One of the flanges is provided with an electrically conductive member, which is located at the center of the flange. This conductive member is provided with a projection, which contacts the internal surface of the drum cylinder, and a flat portion by which the conductive member of the flange contacts the conductive member on the main assembly side of the image forming apparatus. According to the prior art, the conductive member on the main assembly side is kept in contact with the conductive member of the flange by utilizing the resiliency of a spring or the like, in order to keep the electrophotographic sensitive drum electrically connected to the apparatus main assembly (Japanese Laid-open Patent Application 2000-112200).

SUMMARY OF THE INVENTION

The primary object of the present invention is to provide an electrophotographic photosensitive drum capable of reliably establishing electrical connection between it and the main assembly of an electrophotographic image forming apparatus, a process cartridge comprising said electrophotographic photosensitive drum, and an electrophotographic image forming apparatus compatible with said electrophotographic photosensitive drum and process cartridge.

Another object of the present invention is to provide an electrophotographic photosensitive drum capable of wiping its electrically conductive member in order to be reliably grounded, a process cartridge comprising said electrophotographic photosensitive drum, and an electrophotographic image forming apparatus compatible with said electrophotographic photosensitive drum and process cartridge.

Another object of the present invention is to provide an electrophotographic photosensitive drum capable of rotating the first and second electrically conductive members together in order to prevent the conductive members from being frictionally worn, a process cartridge comprising said electrophotographic photosensitive drum, and an electrophotographic image forming apparatus compatible with said electrophotographic photosensitive drum and process cartridge.

According to an aspect of the present invention, there is provided an electrophotographic photosensitive drum usable with an electrophotographic image forming apparatus, comprising a non-circular twisted projection having a cross-section with a plurality of corner portions, the non-circular twisted projection being provided at one longitudinal end of the electrophotographic photosensitive drum, and being engageable with a non-circular twisted hole having a section with a plurality of corner portions, the non-circular twisted hole being disposed at a central portion of a driving rotatable member of a main assembly of the image forming apparatus; and a second electroconductive member contactable with a first electroconductive member electrically connected with a main assembly of the image forming apparatus, the first electroconductive member being disposed in the hole to ground the electrophotographic photosensitive drum, the said second electroconductive member being provided on

the projection and being electrically connected with the electrophotographic photosensitive drum, wherein a contact position between the second electroconductive member and the first electroconductive member moves in interrelation with the projection being moved toward the hole by rotation of the driving rotatable member when the projection is engaged with the non-circular twisted hole of the driving rotatable member.

According to another aspect of the present invention, there is provided an electrophotographic photosensitive drum usable with an electrophotographic image forming apparatus, comprising a non-circular twisted projection having a cross-section with a plurality of corner portions, the non-circular twisted projection being provided at one longitudinal end of the electrophotographic photosensitive drum, and being engageable with a non-circular twisted hole having a section with a plurality of corner portions, the non-circular twisted hole being disposed at a central portion of a driving rotatable member of a main assembly of the image forming apparatus; a second electroconductive member contactable with a first electroconductive member electrically connected with a main assembly of the image forming apparatus, the first electroconductive member being disposed in the hole to ground the electrophotographic photosensitive drum, the second electroconductive member being provided on the projection and being electrically connected with the electrophotographic photosensitive drum, wherein while the projection is in engagement with the hole and is being rotated, the second electroconductive member and the first electroconductive member are integrally rotated while being in contact with each other.

According to a further aspect of the present invention, there is provided a process cartridge detachably mountable to an electrophotographic image forming apparatus, the process cartridge comprising an electrophotographic photosensitive drum; a non-circular twisted projection having a cross-section with a plurality of corner portions, the non-circular twisted projection being provided at one longitudinal end of the electrophotographic photosensitive drum, and being engageable with a non-circular twisted hole having a section with a plurality of corner portions, the non-circular twisted hole being disposed at a central portion of a driving rotatable member of a main assembly of the image forming apparatus; and a second electroconductive member contactable with a first electroconductive member electrically connected with the main assembly of the image forming apparatus, the first electroconductive member being disposed in the hole to ground the electrophotographic photosensitive drum, the second electroconductive member being provided on the projection and being electrically connected with the electrophotographic photosensitive drum, wherein a contact position between the second electroconductive member and the first electroconductive member moves in interrelation with the projection being moved toward the hole by rotation of the driving rotatable member when the projection is engaged with the hole of the driving rotatable member.

According to a further aspect of the present invention, there is provided a process cartridge detachably mountable to an electrophotographic image forming apparatus, the process cartridge comprising an electrophotographic photosensitive drum; a non-circular twisted projection having a cross-section with a plurality of corner portions, the non-circular twisted projection being provided at one longitudinal end of the electrophotographic photosensitive drum, and being engageable with a non-circular twisted hole having a section with a plurality of corner portions, the non-circular twisted hole being disposed at a central portion of a driving rotatable member of a main assembly of the image forming apparatus; and a second electroconductive member contactable with a first electroconductive member electrically connected with the main assembly of the image forming apparatus, the first electroconductive member being disposed in the hole to ground the electrophotographic photosensitive drum, the second electroconductive member being provided on the projection and being electrically connected with the electrophotographic photosensitive drum, wherein while the projection is in engagement with the hole and is being rotated, the second electroconductive member and the first electroconductive member are integrally rotated while being in contact with each other.

According to a further aspect of the present invention, there is provided an electrophotographic image forming apparatus to which a process cartridge is detachably mountable, comprising

(i) rotational drive member;

(ii) a non-circular twisted hole having a cross-section with a plurality of corner portions, the non-circular twisted hole being disposed at a central portion of a driving rotatable member of a main assembly of the apparatus;

(iii) a first electrophotographic member electrically connected with the main assembly of the image forming apparatus;

(iv) a process cartridge demountably mounted to a cartridge mounting portion, the process cartridge including,

an electrophotographic photosensitive drum,

a non-circular twisted projection having a cross-section with a plurality of corner portions, the non-circular twisted projection being provided at one longitudinal end of the electrophotographic photosensitive drum, and being engageable with the non-circular twisted hole, and

a second electroconductive member contactable with a first electroconductive member electrically connected with a main assembly of the image forming apparatus to electrically ground the electrophotographic photosensitive drum, the second electroconductive member being provided on the projection and being electrically connected with the electrophotographic photosensitive drum,

wherein a contact position between the second electroconductive member and the first electroconductive member moves in interrelation with the projection being moved toward the hole by rotation of the driving rotatable member when the projection is engaged with the hole of the driving rotatable member.

According to a further aspect of the present invention, there is provided an electrophotographic image forming apparatus to which a process cartridge is detachably mountable, comprising

(i) rotational drive member;

(ii) a non-circular twisted hole having a cross-section with a plurality of corner portions, the non-circular twisted projection being disposed at a central portion of a driving rotatable member of a main assembly of the apparatus;

(iii) a first electroconductive member electrically connected the main assembly of said image forming apparatus, the first electroconductive member being disposed in the hole;

(iv) a process cartridge demountably mounted to a cartridge mounting portion, the process cartridge including,

an electrophotographic photosensitive drum,

a non-circular twisted projection having a cross-section with a plurality of corner portions, the non-circular twisted projection being provided at one longitudinal end of the

electrophotographic photosensitive drum, and being engageable with the non-circular twisted hole, and

a second electroconductive member contactable with a first electroconductive member electrically connected with the main assembly of the image forming apparatus to electrically ground the electrophotographic photosensitive drum, the second electroconductive member being provided on the projection and being electrically connected with the electrophotographic photosensitive drum,

wherein while the projection is in engagement with the hole and is being rotated, the second electroconductive member and the first electroconductive member are integrally rotated while being in contact with each other.

These and other objects, features, and advantages of the present invention will become more apparent upon consideration of the following description of the preferred embodiments of the present invention, taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a schematic sectional view of the multicolor image forming apparatus in one of the preferred embodiments of the present invention.

FIG. **2** is a schematic sectional view of the image forming apparatus in the preferred embodiment of the present invention, the front cover of which has been opened to expose the opening through which process cartridges are inserted.

FIG. **3** is an enlarged cross-sectional view of the process cartridge in the preferred embodiment of the present invention.

FIG. **4** is a perspective view of the process cartridge in the preferred embodiment of the present invention.

FIG. **5** is a perspective view of the process cartridge in the preferred embodiment of the present invention.

FIG. **6** is a schematic sectional view of the main assembly of the image forming apparatus in the preferred embodiment of the present invention, for describing how the process cartridges are mounted into the main assembly.

FIG. **7** is a perspective view of the photosensitive drum unit in the preferred embodiment of the present invention.

FIG. **8** is a combination of a perspective view and sectional views of the photosensitive drum unit, for describing the steps followed to attach the drum grounding plate.

FIG. **9** is a detailed vertical sectional view of the drum grounding plate in the preferred embodiment of the present invention, describing the structure thereof.

FIG. **10** is a detailed vertical sectional view of the drum grounding plate in the preferred embodiment of the present invention, describing the structure thereof.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, the preferred embodiments of the present invention will be described with reference to the appended drawings.

[Embodiment 1]

(1) General Structure of Image Forming Apparatus

FIG. **1** is a vertical sectional view of the multicolor image forming apparatus in the preferred embodiment of the present invention, showing the general structure thereof. This multicolor image forming apparatus is a full-color laser beam printer which uses an electrophotographic process of a transfer type, and employs a plurality of process cartridges removably mountable in its cartridge compartment. It has a process cartridge compartment in which a plurality of process cartridges are virtually vertically stacked in parallel.

Designated by a referential number **100** is the main assembly of the image forming apparatus (which hereinafter will be referred to simply as apparatus main assembly), and designated by a referential number **101** is a front cover of the apparatus (which hereinafter will be referred to simply as front cover). This front cover **101** is hinged to the apparatus main assembly **100**, being enabled to be opened or closed by being rotated about the hinge shaft **101***a* located at the bottom edge of the front cover **101**. In FIG. **1**, the front cover **101** is closed against the apparatus main assembly **100**, and in FIG. **2**, the front cover **101** has been opened toward an operator, exposing the opening **91** through which process cartridges are inserted into the apparatus main assembly **100**.

Designated by referential numbers **7***a*, **7***b*, **7***c*, and **7***d* are four process cartridges (which hereinafter will be referred to simply as cartridges), that is, first to fourth cartridges for forming toner images of magenta, cyan, yellow, and black colors, which correspond to the color components into which the optical image of an intended full-color image is separated. These cartridges **7** are stacked in parallel in the direction slightly tilted from the true vertical direction, in the cartridge compartment of the apparatus main assembly **100**, being stacked in the listed order, with the cartridge **7***a* positioned at the bottom.

Each cartridge **7**(*a–d*) has an electrophotographic photosensitive member, as an image bearing member **1**(*a–d*), in the form of a drum (which hereinafter will be referred to as photosensitive drum). It also has such electrophotographic processing devices as a charging apparatus (charging means) **2**(*a–d*) for uniformly charging the peripheral surface of the photosensitive drum **1**, a developing apparatus (developing means) **4** for developing the electrostatic latent image formed on the peripheral surface of the photosensitive drum **1** into a toner image (image formed of toner) by adhering toner to the electrostatic latent image, a cleaning apparatus (cleaning means) **6**(*a–d*) for removing the toner remaining on the peripheral surface of the photosensitive drum **1** after the transfer of the toner image onto a transfer medium (recording medium), etc.

The developers stored in the developing apparatuses **4**(*a–d*) of the first to fourth cartridges **7**(*a–d*) are magenta, cyan, yellow, and black toners, respectively.

Designated by reference characters **3***a*, **3***b*, **3***c*, and **3***d* are four scanner units which correspond to the four cartridges **7** one for one. The scanner unit is an exposing means for forming an electrostatic latent image on the peripheral surface of the photosensitive drum **1**, by projecting a beam of laser light (image forming light) L onto the uniformly charged peripheral surface of the photosensitive drum **1**. More specifically, the beam of laser light L outputted from the laser diode (unshown) while being modulated with image formation data is reflected (deflected) by the polygon mirror **9**(*a–d*) being rotated at a high speed by the scanner motor (unshown). The reflected beam of laser light L is sent through the image forming lens **10**(*a–d*), being thereby focused on the uniformly charged peripheral surface of the photosensitive drum **1**. As a result, numerous points of the uniformly charged peripheral surface of the photosensitive drum **1** are selectively exposed, forming an electrostatic image on the peripheral surface of the photosensitive drum **1**.

Designated by a reference number **93** is a partitioning wall in the apparatus main assembly **100**. It partitions the cartridge compartment, in which the four cartridges **7**(*a–d*)

are mounted, from the scanner unit compartment, in which the four scanner units **3**(*a–d*) are located. The beam of laser light L outputted from each of the scanner units **3**(*a–d*) enters the corresponding cartridge **7** through the corresponding window **95**, that is, one of the windows with which the partitioning wall **93** is provided, and scans the peripheral surface of the corresponding photosensitive drum **1**, selectively exposing the numerous points of the peripheral surface of the photosensitive drum **1**.

Designated by a referential number **5** is an electrostatic transferring apparatus (electrostatic transferring means), which is attached to the inward side of the front cover **101**. Thus, the front cover **101** is opened or closed, along with this electrostatic transferring apparatus **5**, against the apparatus main assembly **100** (FIG. **2**). The electrostatic transferring apparatus **5** is provided with an electrostatic transfer belt **11**, which is circularly driven in contact with all of the photosensitive drum **1** of the first to fourth cartridges **7** after the front cover **101** is closed against the apparatus main assembly **100**. Designated by referential numbers **12***a*, **12***b*, **12***c*, and **12***d* are four transfer rollers, which are placed within the loop formed by the electrostatic transfer belt **11**, being positioned so that the electrostatic transfer belt **11** remains pinched between the photosensitive drums **1** of the first to fourth cartridges **7**(*a–d*), and electrostatic transfer belt **11**.

Designated by a reference number **16** is a transfer medium conveying portion located in the bottom portion of the apparatus main assembly **100**. It is a portion for causing a transfer of a medium S to the electrostatic transfer belt **11** of the electrostatic transferring apparatus **5**. Designated by a reference number **17** is a sheet feeder cassette of the transfer medium conveying portion **16**, in which a plurality of transfer media S are stored. Designated by reference numbers **18** and **19** are a sheet feeder roller (semicylindrical roller), and a pair of registration rollers, respectively.

Designated by a referential number **20** is a fixation station located in the top portion of the apparatus main assembly **100**. It fixes to the transfer medium S a plurality of toner images different in color having been transferred onto the transfer medium S. It has a rotational heat roller **21***a*, a pressure roller **21***b* kept pressured upon the heat roller **21***a* to apply pressure to the transfer medium S, etc. Designated by referential numbers **23** and **24** are a pair of discharge rollers, and a delivery tray portion which catches the transfer medium S on which an image has just been formed.

The photosensitive drums **1** in the first to fourth cartridges **7** are sequentially rotated in the counterclockwise direction indicated by an arrow mark with predetermined timings of the image formation sequence. Then, the scanner units **3**(*a–d*) are sequentially driven in synchronism with the rotations of the photosensitive drums **1** of the corresponding cartridges **7**. Further, the electrostatic transfer belt **11** of the electrostatic transferring apparatus **5** is circularly driven by a driver roller **13** in the clockwise direction indicated by an arrow mark at the peripheral velocity matching the peripheral velocities of the photosensitive drums **1**.

As each photosensitive drum **1** is rotated as described above, its peripheral surface is uniformly charged (primary charge) by the charging apparatus **2**(*a–d*) to predetermined polarity (negative in this embodiment) and potential level. The charged peripheral surface of the photosensitive drum **1** is exposed to the beam of laser light L outputted from the scanner unit **3** while being modulated with the image formation data. As a result, an electrostatic latent image in accordance with the image formation data is formed on the peripheral surface of the photosensitive drum **1**.

The electrostatic latent image is developed (in reverse with use of toner, inherent polarity of which is negative, in this embodiment) into a toner image (image formed of toner) by the developing apparatus **4**. As a result, toner images of magenta, cyan, yellow, and black colors are formed on the peripheral surfaces of the photosensitive drums **1** of the first to fourth cartridges **7**(*a–d*), respectively, with predetermined sequence control timings.

Meanwhile, the feed roller **18** of the transfer medium conveying portion **16** is rotationally driven with the predetermined sequence control timing, feeding the transfer mediums S into the apparatus main assembly **100** from the cassette **17**, while separating them one by one. As the leading end of each transfer medium S is conveyed, it comes into contact with the nip formed by the pair of registration rollers **19** which are not being rotated. As it comes into contact with the pair of registration rollers **19**, it is temporarily kept on standby, arcing upward. Then, the registration rollers **19** begin to be rotationally driven in synchronism with the circular movement of the electrostatic transfer belt **11** and the movement of the line of the peripheral surface of the photosensitive drum **1**, at which the toner image begins to be written. As a result, the transfer medium S is conveyed to the tension roller side of the upwardly moving side of the electrostatic transfer belt **11**, and is electrostatically adhered to the surface of the electrostatic transfer belt **11** by the static electricity naturally induced in the electrostatic transfer belt **11**, being thereby reliably held to the electrostatic transfer belt **11**. Then, the transfer medium S is conveyed to the transfer station, or the most downstream station, by the movement of the electrostatic transfer belt **11**. The transfer medium conveying portion **16** may be provided with a charging means, such as an electrostatic adhesion roller, or the like, for intentionally charging the transfer medium S and/or electrostatic transfer belt **11** in order to electrostatically adhere the recording medium S to the electrostatic transfer belt **11**.

While being conveyed as described above, the transfer medium S sequentially receives in layers the toner images formed on the peripheral surfaces of the photosensitive drums **1**; the toner images formed on the peripheral surfaces of the photosensitive drums **1** of the first to fourth cartridges **7** are sequentially transferred in layers onto the recording medium S by the electric field formed between the photosensitive drums **1** and corresponding transfer rollers **12**. In this embodiment, bias with the positive polarity is applied to each transfer roller **12**, causing thereby positive electric charge to be applied to the transfer medium S through the electrostatic transfer belt **11**, generating the electric field, which transfers the toner images on the photosensitive drums **1**, which are positive in polarity, onto the transfer medium S being conveyed in contact with the photosensitive drums **1**(*a–d*), during the image transfer operation.

More specifically, the transfer medium S is electrostatically adhered to the surface of the electrostatic transfer belt **11**, being held thereto, and is conveyed upward by the rotation of the electrostatic transfer belt **11**. While the transfer medium S is conveyed upward by the electrostatic transfer belt **11** as described above, it sequentially receives in layers the toner images of magenta, cyan, yellow, and black colors formed on the peripheral surfaces of the photosensitive drums **1** of the first to fourth cartridges **7**; it receives one toner image in each transfer station. As a result, an unfixed full-color toner image is synthesized on the surface of the recording medium S.

After the reception, in layers, of the four toner images different in color, the transfer medium S is separated from

the electrostatic transfer belt **11** by the curvature of the driver roller **13** of the transfer medium conveying portion **16**, and is conveyed into the fixation station **20**. In the fixation station **20**, the transfer medium S is conveyed through the fixation nip formed by the rotating heat roller **21***a*, and pressure roller **21***b* rotated while being pressed against the heat roller **21***a*. As a result, the plurality of toner images different in color are fixed to the transfer medium S by the heat and pressure applied to the transfer medium S by the pair of rollers **21***a* and **21***b*. After the fixation of the toner images to the transfer medium S in the fixation station **20**, the transfer medium S is discharged by the pair of discharge rollers **23** into the external delivery tray **24** of the apparatus main assembly **100**, with the image bearing surface of the transfer medium S facing downward.

The residues such as the toner remaining on the peripheral surface of the photosensitive drum **1** in each of the first to fourth cartridges **7** after the transfer of the toner image onto the transfer medium S are removed by the cleaning apparatus **6**, and the photosensitive drum **1** is used for the following image formation.

(2) Process Cartridge **7**

FIG. **3** is an enlarged cross sectional view of the cartridge **7**, and FIGS. **4** and **5** are schematic perspective views of the cartridge **7**.

In this embodiment, the photosensitive drum **1** is an integral part of the cartridge **7**, and therefore, it is removably mounted into the apparatus main assembly **100** as the cartridge **7** is removably mounted into the apparatus main assembly **100**.

In the following description of this embodiment, the widthwise direction of the cartridge **7** or the structural components thereof is the direction parallel to the direction in which the cartridge **7** is mounted into, or removed from, the apparatus main assembly **100**, whereas the lengthwise direction means the direction intersectional (perpendicular) to the direction in which the cartridge **7** is mounted into, or removed from, the apparatus main assembly **100**. The front side of the cartridge **7** means the side of the cartridge **7** which faces the direction from which the cartridge **7** is inserted into the apparatus main assembly **100**, or the direction toward which the cartridge **7** is removed from the apparatus main assembly **100**; in other words, it is the side of the cartridge **7** where the hole of the cartridge **7** through which the photosensitive drum **1** is exposed is present. The rear side of the cartridge **7** means the side opposite to the front side. The left and right of the cartridge **7** means the left and right sides, as seen from the front side of the cartridge **7**. The top and bottom sides of the cartridge **7** means the sides which will be on the top and bottom sides, respectively, after the mounting of the cartridge **7** into the apparatus main assembly **100**.

The first to fourth cartridges **7**(*a–d*) are the same (in structure) except for the developers stored in the toner container portions (developer storage portions) of the developing apparatuses **4**(*a–d*) of the first to fourth cartridges **7**(*a–d*); the toner container portions of the first to fourth cartridges **7***a*, **7***b*, **7***c*, and **7***d* contain magenta toner, cyan toner, yellow toner, and black toner, respectively.

The cartridge **7** is made up of the cleaner unit **50** and development unit **4**A. The cleaner unit **50** comprises the photosensitive drum **1**, charging means **2**, and cleaning means **6**, whereas the development unit **4**A comprises the developing means for developing an electrostatic latent image on the peripheral surface of the photosensitive drum **1**.

The cleaner unit **50** also comprises a frame **51** to which the photosensitive drum **1**, primary charging apparatus **2** for uniformly charging the photosensitive layer, or the outermost layer, of the photosensitive drum **1**, cleaning blade **60** as the cleaning means **6** for removing the developer (residual toner) remaining on the peripheral surface of the photosensitive drum **1** after the image transfer, and a flexible sheet **80**, etc., are attached.

The photosensitive drum **1** comprises an aluminum cylinder, and a photosensitive layer formed on the peripheral surface of the aluminum cylinder. It is provided with flanges **72** and **75**, which are attached to the lengthwise ends of the photosensitive drum **1**, one for one. The flanges **72** and **75** are rotatably supported by supporting members (bearings) **31***a* and **31***b*, with which the left and right walls of the cleaner unit frame **51** are provided. Of the two flanges **72** and **75**, the flange **72** functions as a driving force transmitting member which couples with the rotational driving force transmitting member (unshown) of the apparatus main assembly **100**, and receives the driving force from the driving force transmitting member (unshown) of the apparatus main assembly **100**. The configurations of the driving force transmitting member of the apparatus main assembly **100** and the flange **72**, and the manner of their connection, will be described in Section (4).

As the charging apparatus **2**, a charging apparatus of a contact type may be used. The charging member is an electrically conductive roller, the peripheral surface of which is placed in contact with the peripheral surface of the photosensitive drum **1**. The roller is rotated by the rotation of the photosensitive drum **1**. The peripheral surface of the photosensitive drum **1** is uniformly charged by applying charge bias voltage to the roller while the roller is rotated by the rotation of the photosensitive drum **1**.

The residual toner (waste toner) is removed from the peripheral surface of the photosensitive drum **1** by the cleaning blade **60**, and the removed residual toner is stored in the waste toner chamber (residual toner storage chamber) **55** located above the cleaning blade **60**. Incidentally, the toner remaining on the peripheral surface of the photosensitive drum **1** after the toner image transfer therefrom moves past the contact area between the flexible sheet **80** and the peripheral surface of the photosensitive drum **1**, and reaches the cleaning blade **60**. The flexible sheet **80** is attached to the cleaner unit frame **51** in order to prevent the residual toner from leaking out of the cleaner unit frame **51** after the residual toner is removed from the peripheral surface of the photosensitive drum **1** by the cleaning blade **60**.

The development unit **4**A comprises: a development sleeve **40**, which is rotated (in the direction indicated by arrow mark in FIG. **3**), with a minute gap maintained between the peripheral surfaces of the development sleeve **40** and photosensitive drum **1** by a pair of spacer rings **40***a;* and development means frames **45***a* and **45***b*, in which the toner is stored. The developing means frames **45***a* and **45***b* are joined by ultrasonic welding or the like means, forming the container unit **46**. The development sleeve **40** is rotatably supported by the developing means container unit **46**, with a pair of bearings placed between the development sleeve **40** and the unit **46**. In the adjacencies of the peripheral surface of the development sleeve **40**, a toner supply roller **43**, which is rotated in the clockwise direction indicated by an arrow mark in contact with the peripheral surface of the development sleeve **40**, and the development blade **44**, are located. Further, in the toner container portion (developer storage portion) **41** of the developing means container unit **46**, a toner conveyance mechanism **42** for conveying the toner

(unshown) stored in the toner container portion **41**, to the toner supply roller **43** while stirring it, is located.

The development unit **4**A is provided with a pair of connective holes **47**, which are located at the lengthwise ends of the container unit **46**, one for one, whereas the cleaner unit frame **51** of the cleaner unit **50** is provided with a pair of supportive holes **52**, which are located at the length ends of the cleaner unit frame **51**. The development unit **4**A and cleaner unit **50** are connected to each other by inserting a pair of pins **49** through the connective holes **47** and supportive holes **52** while holding the two units so that the connective holes **47** and supportive holes **52** align one for one. As a result, the entirety of the development unit **4**A becomes rotatable about the pins **49**, being thereby movable relative to the cleaner unit **50** while remaining suspended from the cleaner unit **50**. Further, the development unit **4**A is kept pressured by a pair of springs (unshown) in the direction to rotate the development unit **4**A about the pins **49** so that the spacer rings **40***a* of the development sleeve **40** are kept in contact with the photosensitive drum **1** in the cleaner unit **50**.

During a developing operation, the toner in the toner container **41** is conveyed by the stirring mechanism **42** to the toner supply roller **43**, which is being rotated in the clockwise direction, in contact with the development sleeve **40** which is being rotated also in the clockwise direction. As a result, the peripheral surface of the supply roller **43** is rubbed against the peripheral surface of the development sleeve **40**, causing the toner on the peripheral surface of the supply roller **43** to be transferred onto the peripheral surface of the development sleeve **40**. The toner having been borne on the peripheral surface of the development sleeve **40** is brought by the rotation of the development sleeve **40** to the development blade (toner layer regulating member) **44**. Thus, as the development sleeve **40** is further rotated, the layer of the toner on the peripheral surface of the development sleeve **40** is regulated in thickness by the development blade **44**, into a thin layer of the toner uniform in thickness, while being given a predetermined amount of electric charge. Then, the thin layer of the toner on the peripheral surface of the development sleeve **40** is brought by the further rotation of the development sleeve **40** to the development station, in which the distance between the photosensitive drum **1** and development sleeve **40** is extremely small. In the development station, the toner from the thin layer of the toner on the peripheral surface of the development sleeve **40** is adhered to the electrostatic latent image on the peripheral surface of the photosensitive drum **1**, by the development bias applied to the development sleeve **40** from the electrical power source (unshown); in other words, the latent image is developed. More specifically, the development sleeve **40** forms (develops) a toner image on the peripheral surface of the photosensitive drum **1** by transferring toner onto the numerous points of the electrostatic latent image, which are lower in potential level.

The toner which did not contribute to the development of the latent image, that is, the toner which remained on the development sleeve **40**, is returned by the further rotation of the development sleeve **40**, into the container unit **46**, in which it is stripped from the development sleeve **40** by the supply roller **43**, in the area in which the peripheral surfaces of the supply roller **43** and development sleeve **40** are rubbing against each other; in other words, the residual toner is recovered into the container unit **46**. The recovered toner is mixed into the toner in the container unit **46** by the stirring mechanism **42**.

Designated by a referential number **54** is a shutter for protecting the photosensitive drum **1**. The shutter **54** is attached to the cleaner unit frame **51**. It is movable by a shutter mechanism (unshown) between the closed position (FIGS. **3**–**5**) in which it covers the photosensitive drum exposure window on the front side of the cartridge **7**, and the open position (indicated by double dot chain line in FIG. **3**) into which it is moved downward from the closed position to expose the photosensitive drum exposure window. When the cartridge **7** is out of the apparatus main assembly **100**, the shutter **54** is kept in the closed position, protecting thereby the portion of the peripheral surface of the photosensitive drum **1**, which will remain exposed if there were no the shutter **54**. As the front cover **101** of the apparatus main assembly **100** is closed after the mounting of the cartridge **7** into the apparatus main assembly **100**, the shutter **54** is moved into the open position by the shutter mechanism (unshown) which is moved by the movement of the front cover **101**. As a result, the electrostatic transfer belt **11** is allowed to be placed in contact with the peripheral surface of the photosensitive drum **1** through the aforementioned exposure window of the cartridge **7** (FIG. **1**).

Designated by a referential number **53** is a cartridge insertion guide of the cleaner unit frame **51**. There are two cartridge insertion guides **53** located at the left and right lengthwise ends, one for one. Designated by a referential number **90** is a handle to be used when mounting the cartridge **7** into the apparatus main assembly **100** or removing it therefrom. There are two handles **90** which project frontward from the left and right lengthwise ends of the cartridge **7**.

(3) Method for Mounting or Removing Cartridge **7**

Next, the method for mounting the cartridge **7** into the apparatus main assembly **100** or dismounting it therefrom will be described. The operation for mounting the cartridges **7** into the apparatus main assembly **100** or removing them therefrom is to be carried out after opening the front cover **101** of the apparatus main assembly **100** to fully expose the cartridge insertion opening **91** of the apparatus main assembly **100** (FIGS. **2** and **6**). When the front cover **101** is in the closed state (FIG. **1**), it remains locked to the apparatus main assembly **100** by a latching mechanism (unshown). Thus, in order to mount or remove the cartridge **7**, first, the front cover **101** must be unlocked from the apparatus main assembly **100** by unlatching the latching mechanism, so that the front cover **101** can rotated (opened), along with the electrostatic transferring apparatus **5** attached thereto, frontward of the apparatus main assembly **100**, about the hinge shaft **101***a* located at the bottom of the front cover **101**. As the front cover **101** is rotated (opened) all the way, the cartridge insertion opening **91** of the apparatus main assembly **100** becomes fully exposed.

Through the cartridge insertion opening **91**, the first to fourth cartridges **7** are mountable into the cartridge compartment of the apparatus main assembly **100**, in a manner to be stacked in parallel in the direction slightly tilted from the true vertical direction, in the listed order, that is, with the first cartridge mounted at the bottom. More specifically, the cartridge compartment is divided into four cartridge slots, which are the magenta, cyan, yellow, and black cartridge slots, listing from the bottom. The four cartridge slots are identical in cartridge mounting mechanism. Each cartridge slot is provided with a pair of rough guides **103**, a pair of middle guides **104**, and a pair of guiding grooves **105**, for guiding the cartridge **7** into the image forming position. FIG. **6** shows the inward side of the right plate of the apparatus

main assembly **100**. The inward side of the left plate is symmetrical with that of the right plate.

An operator is to hold the cartridge **7** by the left and right handles **90**, by grasping the handles **90** with both hands, and to insert the cartridge **7** into the proper cartridge slot through the cartridge insertion opening **91**, so that the rear side of the cartridge **7**, that is, the side opposite to the side where the photosensitive drum **1** is exposed, faces forward, and also, so that the left and right lengthwise end portions of the cartridge **7** will be rested on the left and right rough guides **103** of the apparatus main assembly **100**, respectively. As the cartridge **7** is inserted deeper into the apparatus main assembly **100**, the aforementioned pair of cartridge insertion guides **53** are moved onto the middle guides **104**, causing thereby the cartridge **7** to be lifted from the rough guides **103**. Thereafter, the cartridge **7** is guided by the middle guides **104**.

As the cartridge **7** is inserted even deeper into the apparatus main assembly **100**, the left and right supporting members **31***a* and **31***b* of the cartridge **7** are inserted into the left and right guiding grooves **105**, respectively. Then, as the cartridge **7** is further inserted, the supporting members **31***a* and **31***b* come into contact with the deepest end of the guiding grooves **105**, and prevent the further insertion of the cartridge **7** into the apparatus main assembly **100**. As a result, the cartridge **7** is precisely positioned relative to the apparatus main assembly **100** in terms of the widthwise direction.

After the cartridges **7** are inserted into the proper cartridge slots as described above, the front cover **101**, which was kept open, is to be closed, and to be locked to the apparatus main assembly **100** by latching the latching mechanism (unshown). The following are accomplished by the means (unshown) which is moved by the closing movement of the front cover **101**:

1) Precise positioning of each cartridge **7** relative to the apparatus main assembly **100** in terms of the widthwise direction of each cartridge **7**, and keeping the cartridge **7** pressured in the direction in which the cartridge **7** is inserted;
2) Moving the shutter **54** of each cartridge **7** into the open position; and
3) Starting the multiple pre-rotations of the image forming apparatus in order to couple the flange **72**, on the driven side, of the photosensitive drum **1** of each cartridge **7** with the driving force transmitting member **73** on the main apparatus side.

The function of precisely positioning each cartridge **7** relative to the apparatus main assembly **100** in terms of the widthwise direction of the cartridge **7** is carried out by a pair of pressing members (unshown), which are moved by the movement of the front cover **101**. When the front cover **101** is open, that is, when the front cover **101** is in the state in which the cartridges **7** can be mounted into, or removed from, the apparatus main assembly **100**, the pressing members are in the positions into which they have been retracted from the guiding grooves **105**. Thus, when the cartridge **7** is inserted, the pressing members do not interfere with the supporting members **31***a* and **31***b* of the cartridge **7**. However, as the front cover **101** is closed after the insertion of the cartridges **7**, the pressing members are moved into the positions in which they press the supporting members **31***a* and **31***b* against the deepest end of the guiding grooves **105**, precisely positioning thereby the cartridge **7** relative to the apparatus main assembly **100** in terms of the widthwise direction.

With each cartridge **7** precisely positioned relative to the apparatus main assembly **100**, the flange **72**, on the driven side, of the cartridge **7**, and the driving force transmitting rotational member **73** of the apparatus main assembly **100** become coupled with each other, making it possible for the diving force from the motor (unshown) of the apparatus main assembly **100** to be transmitted to the flange **72**, on the driven side, of the cartridge **7**, through the driving force transmitting rotational member **73**; in other words, it becomes possible for the photosensitive drum **1** of each cartridge **7** to be rotationally driven. It should be noted here that the development sleeve **40**, toner conveyance mechanism **42**, and toner supply roller **43** are driven by the rotation of the photosensitive drum **1** through the gear train (unshown).

Also, electrical connection is established between the electrical contacts (unshown) on the cartridge side and the electrical contacts (unshown) on the main assembly side, making it possible for charge bias and development bias to be applied to the cartridge **7** from the power source (unshown) of the apparatus main assembly **100**, and also, for information or the like to be exchanged between the memory element on the cartridge side and the control circuit on the apparatus main assembly side. The structure for grounding the photosensitive drum **1** will be described later in Section (4).

All that is necessary to remove the cartridge **7** from the apparatus main assembly **100** is to carry out in reverse the above described steps for mounting the cartridge into the apparatus main assembly **100**. That is, first, the aforementioned latching mechanism is to be unlatched to unlock the front cover **101** from the apparatus main assembly **100**. Then the front cover **101** is rotated downward about the hinge shaft **101***a* located at the bottom of the front cover **101** in order to open the front cover **101** frontward. As the front cover **101** is rotated downward, the cartridge pressing members are retracted by the means which moved by the opening movement of the front cover **101**, being stopped from pressing the cartridge **7**. Also as the front cover **101** is opened, the driving force transmitting rotational member **73** becomes disengaged from the flange **72** of the driven side, and the shutter **54** is moved into the open position. Then, an operator is to grasp the handles **90** of the cartridge **7** with both hands, and to pull the cartridge **7** in the direction opposite to the direction in which the cartridge **7** is pushed when it is mounted into the apparatus main assembly **100**. This will remove the cartridge **7** from the apparatus main assembly **100**.

(4) Method for Connecting Drum Grounding Plate **71**)

Next, referring to FIGS. **7**–**10**, the method for connecting the drum grounding plate **71** attached to the flange **72** on the driven side will be described in more detail.

FIG. **7** is a perspective view of the photosensitive drum (which hereinafter will be referred to as photosensitive drum unit) **1**, and the driving force transmitting rotational member **73** on the apparatus main assembly side. FIG. **8** is a combination of a perspective view and vertical sectional views of the photosensitive drum unit **1**, showing the steps followed to assemble the photosensitive drum unit **1**. FIGS. **9** and **10** are enlarged views of the E portion in FIG. **8**, showing the state of connection between the drum grounding plate **71** and drive shaft **70**. FIG. **9** shows the positional relationship between the drum grounding plate **71** and drive shaft **70** at the moment the two have just come into contact with each other, or immediately before the two become separated from each other. FIG. **10** shows the positional

relationship between the drum grounding plate **71** and drive shaft **70** when the cartridge **7** has been successfully mounted, being therefore ready for image formation.

First, referring to FIG. **7**, the structure of the photosensitive drum unit **1** will be described.

The photosensitive drum unit **1** has a drum cylinder **74**, which comprises, as described before, an aluminum cylinder and a layer of photosensitive substance coated on the peripheral surface of the aluminum cylinder. The photosensitive drum unit **1** also has a pair of flanges **72** and **75**, which are pressed into the openings of the lengthwise ends of the drum cylinder **74**, being virtually integrated with the drum cylinder **74**. The flanges **72** and **75** are rotatably supported by the bearing members **31***a* and **31***b* (FIGS. **4** and **5**) with which the cartridge **7** is provided. To the flange **72** located at one of the lengthwise ends of the photosensitive drum unit **1**, the driving force is transmitted from the motor (unshown) within the apparatus main assembly **100** through the driving force transmitting rotational member **73**, rotating thereby the photosensitive drum unit **1**. In this embodiment, hereinafter, the flange **72** to which the driving force is transmitted from the apparatus main assembly **100** will be referred to as the driver flange **72**, whereas the other flange will be referred to as the non-driver flange **75**.

FIG. **9** is an enlarged view of the joint between the driver flange **72** and driving force transmitting rotational member **73**. The driver flange **72** is provided with a spiral projection **72***a* (coupling projection) with a non-circular cross section; the cross section of the spiral projection has a plurality of apexes. The apparatus main assembly **100** is provided with the driving force transmitting rotational member **73** for transmitting the driving force from the motor (unshown) within the apparatus main assembly **100**, to the photosensitive drum unit **1**. The driving force transmitting rotational member **73** has a spiral hole **73***a* (coupling hole) with a non-circular cross section; the cross section of the spiral hole has a plurality of apexes. The axial line of the spiral hole **73***a* coincides with that of the driving force transmitting rotational member **73**. As the cartridge **7** is mounted into the apparatus main assembly **100**, the spiral projection **72***a* enters the spiral hole **73***a*, enabling the rotational driving force to be transmitted to the photosensitive drum unit **1**. As the driving force transmitting rotational member **73** is rotated by the motor on the apparatus main assembly side, a force A' which acts in a direction to pull the spiral projection **72***a* into the spiral hole **73** is generated, causing the driving force transmitting rotational member **73** and the photosensitive drum unit **1** to be drawn toward each other.

The spiral projection **72***a* is provided with an electrically conductive second member **71** (which hereinafter will be referred to as a drum grounding plate) for establishing an electrical connection between the photosensitive drum unit **1** and apparatus main assembly **100**. The drum grounding plate **71** is located at the center of the spiral projection **72***a*, in terms of the radius direction of the projection **72***a*, and is placed in contact with the internal surface of the drum cylinder **74**. The driving force transmitting rotational member **73** is provided with an electrically conductive first member **70** (which hereinafter will be referred to as a drive shaft) for establishing our electrical connection between the photosensitive drum unit **1** and apparatus main assembly **100**. The electrically conductive first member, or the drive shaft **70**, projects a predetermined distance from the center of the bottom of the spiral hole **73***a*. The first and second electrically conductive members **70** and **71** allow the residual electric charge of the photosensitive drum unit **1** to escape to the apparatus main assembly **100**.

Referring to FIG. **8**, the drum grounding plate **71** is a single-piece member, and flat contact portion **71***a*, and a contact portion **71***b* in the form of an arm. The flat contact portion **71***a*, as one of the contacting means, is supported by the flat portion **72***g* provided within the driver flange **72**. The arm-shaped contact portion **71***b* as the other contacting means is formed by bending or the like method. In terms of the lengthwise direction, the arm-like contact portion **71***b* extends outward beyond the flat contact portion **71***a*.

Referring to FIG. **9**, the driver shaft **70**, which is on the apparatus main assembly side, rotates with the driving force transmitting rotational member **73**. The driver flange **72** is provided with a hole **72***j* into which the drive shaft **70** fits , and which is located roughly at the center of the driver flange **72** in terms of the radius direction. When the image forming apparatus is actually ready for image formation, the tip **70***a* of the drive shaft **70** is in contact with the flat contact portion **71***a*. The flat contact portion **71***a* is supported (backed) by the flat portion **72***g* provided within the driver flange **72**. As the drive force transmitting rotational member **73** is rotated, with the spiral projection **72***a* being in the spiral hole **73***a*, the force A' which acts in the direction to pull the projection **72***a* into the hole **73***a* is generated. The contact pressure generated by the force A' applies to the tip **70***a* of the drive shaft **70** and the flat contact portion **71***a*. This concludes the coupling between the driving force transmitting rotational member **73** and driver flange **72** (photosensitive drum unit **1**). The driving force transmitting rotational member **73** is provided with a spring (unshown) for keeping the connected photosensitive drum unit **1** pressured in the lengthwise direction. Thus, the non-driver flange **75** is kept pressured upon the cleaner unit **50** (cartridge **7**) through the photosensitive drum unit **1**. Therefore, the cleaner unit **50** is kept pressed upon-the side plate **102** of the apparatus main assembly **100**. As a result, the cartridge **7** is precisely positioned-relative to the apparatus main assembly **100** in terms of the lengthwise direction.

Next, the process through which the drum grounding plate **71** becomes connected to its counterpart will be described in detail. Referring to FIG. **9** which shows the positional relationship between the drum grounding plate **71** and drive shaft **70** at the moment the two have just come into contact with each other, or immediately before the two become separated from each other, prior to the insertion of the cartridge **7** into the apparatus main assembly **100**, the driving force transmitting rotational member **73** of the apparatus main assembly **100** remains retracted, being thereby prevented from interfering with the insertion of the cartridge **7**. As the cartridge **7** is mounted into the apparatus main assembly **100**, and the front cover **101** of the apparatus main assembly **100** is closed (FIG. **2**), the driving force transmitting rotational member **73** is moved, while being rotated, toward the driver flange **72** in the lengthwise direction. As a result, the cartridge **7** (driver flange **72**) and the apparatus main assembly **100** (driving force transmitting rotational member **73**) become partially connected; the spiral projection **72***a* partially enters the spiral hole **73***a*.

In this state, the pre-rotation step (in which the apparatus is driven for a predetermined length of time between when a print start signal is inputted and when an actual image forming operation starts) is carried out. During this pre-rotation step, a rotational driving force is inputted from the driving force transmitting rotational member **73** into the drive flange **72** integral with the photosensitive drum unit **1**. There occurs sometimes that the spiral projection **72***a* fails to enter the spiral hole **73***a* (the driver flange **72** fails to mesh with the driving force transmitting rotational member **73**)

because they fail to synchronize in rotational phase during the preceding step, that is, the closing of the front cover **101** of the apparatus main assembly **100**. However, the driving force transmitting rotational member **73** is kept pressed upon **20** the photosensitive drum unit **1** (driver flange **72**) in the lengthwise direction, as described above. Therefore, the driver flange **72** and the driving force transmitting rotational member **73** are eventually made to synchronize in rotational phase, meshing therefore with each other, during this pre-rotation period.

As the rotational driving force is inputted, with the driving force transmitting rotational member **73** and the driver flange **73** partially meshed (the spiral projection **72***a* being partially placed in the spiral hole **73***a*), the force A', which acts in the direction to draw the driving force transmitting rotational member **73** and driver flange **72** (photosensitive drum unit **1**) toward each other (draw spiral projection **72***a* into spiral hole **73***a*), is generated. As a result, the spiral projection **72***a* is drawn into the spiral hole **73***a*. Therefore, in the driver flange **72**, the drive shaft **70** and drum grounding plate **71** are drawn toward each other, causing the tip of the arm-shaped contact portion **71***b* of the drum grounding plate **71** to come into contact with the tip of the drive shaft **70**, at a point b**1** (FIG. **9**).

As the input of the rotational driving force is continued, the generation of the force A' also continues, causing the tip of the arm-shaped contact portion **71***b* of the drum grounding plate **71** to follow the surface of the tip **70***b* of the drive shaft **70** in the radius direction of the drive shaft **70** as indicated by a letter c. In other words, the contact point between the tip of the arm-shaped portion **71***b* of the drum grounding plate **71** and drive shaft **70** shifts as the spiral projection **72***a* is drawn into the spiral hole **73***a*. Since the drum grounding plate **71** is formed of an electrically conductive elastic substance, it elastically deforms. Therefore, the tip in the arm-shaped portion **71***b* of the drum grounding plate **71** slides on the surface of the tip **70***b* of the drive shaft **70**, while applying a slight pressure upon the surface of the tip **70***b* of the drive shaft **70**, while the spiral projection **72***a* is drawn into the spiral hole **73***a*.

In other words, as the input of the rotational driving force continues, the spiral projection **72***a* is drawn into the spiral hole **73***a* so that the drive shaft **70** and drum grounding plate **71** are drawn to each other. As a result, the tip **70***a* of the drive shaft **70** comes into contact with the flat portion **71***a* of the drum grounding plate **71** as shown in FIG. **10**. In other words, at the same time as the cartridge **7** is precisely positioned relative to the apparatus main assembly **100**, electrical connection is established between the apparatus main assembly **100** and present invention drum unit **1** by the contact pressure A, which is the combination of the force A' and the pressure generated by the resiliency of the springs (unshown). Until the tip **70***a* of the drive shaft **70**, and the flat portion **71***a* of the drum grounding plate **71** come into contact with each other, the drive shaft **70** is continuously rotated relative to the drum grounding plate **71**. Thus, during this period, the tip of the arm-shaped portion **71***b* keeps on sliding on the surface of the tip **70***b* of the drive shaft **70**, not only in the lengthwise direction of the drive shaft **70**, but also, in the radially outward direction of the drive shaft **70**. In other words, the tip of the arm-shaped portion **71***b* of the drum grounding plate **71** slides on the surface of the tip of the shaft **70**, from the contact point b**1** (FIG. **9**) to the contact point b**2** (FIG. **10**) as indicated by the referential letter c in FIGS. **9** and **10**. Thereafter, the electrical connection between the apparatus main assembly **100** and photosensitive drum unit **1** is maintained at the contact point b**2** between the tip of the arm-shaped portion **71***b* of the drum grounding plate **71**, and the surface of the tip **70***a* of the shaft **70**, by the contact pressure B generated by the arm-shaped portion **71***b* of the drum grounding plate **71**.

With the employment of the above-described method for electrically connecting the drum grounding plate **71** to the drive shaft **70**, the contact point between the photosensitive drum unit **1** and the drive shaft **70** does not shift (slide) in the lengthwise direction during the actual image forming operation. That is, while the driver flange **72** and the driving force transmitting rotational member **73** are rotating together, with the spiral projection **72***a* engaged in the spiral hole **73***a*, the drum grounding plate **71** (flat portion **71***a* and arm-shaped portion **71***b*) and the drive shaft **70** (tip **70***a* of drive shaft) rotate together while remaining in contact with each other. Therefore, the cartridge **7** is reliably grounded to the apparatus main assembly **100**. The drive shaft **70**, which rotates with the driving force transmitting rotational member **73**, is connected to the power supplying member (unshown) of the apparatus main assembly **100**. The portion of the drive shaft **70** (portion of the power supplying member), which rubs against the power supplying member is coated with electrically conductive grease to assure that the cartridge **7** is grounded to the apparatus main assembly **100**. It should be noted here that the contact point between the photosensitive drum unit **1** and drive shaft **70**, which a user can touch, is not coated with electrically conductive grease. With the provision of the above-described structural arrangement in this embodiment of the present invention in which the contact point between the apparatus main assembly **100** and the cartridge **7** does not shift in the lengthwise direction during a period in which an image is actually formed, the cartridge **7** remains better grounded than with the provision of the structural arrangement in accordance with the prior art. Further, while the driver flange **72** (drum grounding plate **71**) and the drive shaft **70** rotate together, with the spiral projection **72***a* remaining in the spiral hole **73***a*, the wall of the hole **72***j* into which the drive shaft **70** fits, and drum grounding plate **71**, are prevented from being worn by the friction between the two, minimizing therefore their frictional wear.

The contact pressure between the flat portion **71***a* of the drum grounding plate **71** and the tip **70***a* of the drive shaft **70** is generated by the force A' generated as the drive shaft **70** is rotated by the rotational driving force transmitted thereto. In other words, the contact pressure is generated only while the driving force is inputted. Therefore, the members pertinent to the electrical connection between the apparatus main assembly **100** and cartridge **7** are less likely to suffer from fatigue. In addition, at the beginning of the transmission of the driving force, the contact point between the tip **70***a* of the drive shaft **70** and the flat portion **71***a* of the drum grounding plate **71** slightly shifts, creating the wiping effect.

As for the grounding of the photosensitive drum unit **1** through the arm-shaped portion **71***b*, or the other contact point, of the drum grounding plate **71**, as the spiral projection **72***a* is drawn into the spiral hole **73***a*, the tip of the arm-shaped portion **71***b* slides on the surface of the tip **70***b* of the drive shaft **70** while being kept in contact with the surface by its own resiliency. In other words, it wipes itself while wiping the surface of the tip **70***b* of the shaft **70**, better grounding therefore the photosensitive drum unit **1**.

The configuration of the tip (inclusive of points **70***a* and **70***b*) of the drive shaft **70** does not need to be limited to the one in this embodiment. It has only to be such that allows the tip of the arm-shaped portion **71***b* of the drum grounding

member **71** to be slid on the surface of the tip (inclusive of points **70***a* and **70***b*) of the shaft **70** as the spiral projection **72***a* is drawn into the spiral hole **73***a*.

Referring to FIGS. **9** and **10**, in this embodiment, the arm-shaped portion **71***b* of the drum grounding plate **71** is shaped so that while its tip slides on the surface of the tip **70***a* of the drive shaft **70**, the angle of the surface of the tip of the arm-shaped portion **71***b* relative to the line tangential to the surface of the tip **70***b* of the drive shaft **70** remains as small as possible, making it easier for the tip of the arm-shaped portion **71***a* to slide on the surface of the tip **70***a* of the drive shaft **70**. Obviously, as long as the arm-shaped portion **71***b* is shaped so that as the spiral projection **72***a* is drawn into the spiral hole **73***a*, the tip of the arm-shape portion **71***b* is allowed to slide on (move in contact with) the surface of the tip **70***a* of the drive shaft **70**, the same wiping effect as that realized by this embodiment can be realized. In other words, the arm-shaped portion **71***b* of the drum grounding plate **71** may be differently bent from the shape in which it is bent in this embodiment.

Further, in this embodiment, the arm-shaped portion **71***b* and flat portion plate **71***b* of the drum grounding plate **71** are formed by cutting and bending a single piece of an electrically conductive springy plate. However, the same effects as those described above can be obtained even if two or more electrically conductive members are combined to form the drum grounding plate **71** having the flat and arm-shaped portions **71***a* and **71***b*. Further, even if the spiral hole **73***a* with a non-circular cross section and spiral projection **72***a* with a non-circular cross section are switched in position, the same effects as those obtained by this embodiment can be obtained. In other words, even if the driver flange **72** is provided with a non-circular spiral hole **73***a* which has a cross section having a plurality of apexes, and the rotational axis of which coincides with that of the flange **72**, and the driving force transmitting rotational member **73** of the apparatus main assembly **100** is provided with a spiral projection (**72***a*) which has a cross section having a plurality of apexes, and the rotational axis of which coincides with that of the driving force transmitting rotational member **73**, the same effects as those obtained by this embodiment can be obtained.

Further, the drive shaft **70** and drum grounding plate **71** may be switched in position. In other words, even if the drum grounding plate **71** is positioned at the center of the spiral hole **73***a* with a non-circular cross section, and the spiral projection **72***a* with a non-circular cross section is provided with the drive shaft **70**, the rotational axis of which coincides with that of the spiral projection **72***a*, the same effects as those obtained by this embodiment can be obtained. However, placing the drum grounding plate **71** at the center of the spiral projection **72***a* with a non-circular cross section makes the hole **72***j* of the spiral projection **72***a*, through which the drive shaft **70** is put to be connected to the drum grounding plate **71**, identical in diameter as the drive shaft **70**, and therefore, making it possible to reduce the spiral hole **73***a* in cross section. Therefore, placing the drum grounding plate **71** at the center of the spiral projection **72***a* is superior for the purpose of preventing foreign objects from coming into contact with the springy drum grounding plate **71** from outside.

(5) Attachment of Drum Grounding Plate **71**

Next, referring to FIG. **8**, the steps to be followed in order to attach the drum grounding plate **71** to the driver flange **72** will be described in detail.

FIG. **8** is a combination of a perspective view and vertical sectional views of the driver flange **72** and drum grounding plate **71**, showing the steps to be followed to attach the drum grounding plate **71**.

The drum grounding plate **71** is attached to the driver flange **72** following steps 1)–8) in the numerical order. FIG. **8** (step **1**) shows the drum grounding plate **71** and driver flange **72** prior to the attachment of the drum grounding plate **71** to the driver flange **72**.

The drum grounding plate **71** in this embodiment is bent roughly in the shape of a letter L. In the sectional view of the drum grounding plate **71**, at a plane perpendicular to the vertical portion of the letter "L" (direction perpendicular to lengthwise direction described before), the drum grounding plate **71** has a pair of projections **71***c* (by which drum grounding plate **71** is guided), which perpendicularly project from the longest edges of the drum grounding plate **71**, one for one. The drum grounding plate **71** also has: a positioning hole **71***d* for precisely positioning the drum grounding plate **71** within the driver flange **72**; a projection **71***e* by which the drum grounding plate **71** is placed in contact with the internal surface of the drum cylinder to establish electrical connection between the drum grounding plate **71** and the drum cylinder **74**; and aforementioned flat and arm-shaped portion **71***a* and **71***b*.

The driver flange **72** is provided with a positioning pin **72***b* which fits into the positioning hole **71***d* of the drum grounding plate **71**, and the spiral projection **72***a* (coupling portion) with a non-circular cross section, which has a plurality of apexes and projects from the end of the driver flange **72**. Referring to FIG. **8** (step **2**), the driver flange **72** is provided with an internal space **72***c* into which the drum grounding plate **71** is inserted. When attaching the drum grounding plate **71** to the driver flange **72**, the drum grounding plate **71** is to be inserted, from its contact point side, into the driver flange **72** from the rear end of the driver flange **72** toward the front end, provided that the portion of the driver flange **72**, which has the coupling portion, is the front end portion.

As the drum grounding plate **71** is inserted further into the driver flange **72** as shown in FIG. **8** (step **3**), the pair of projections **71***c*, which perpendicularly project from the longest edges of the drum grounding plate **71**, come into contact with a pair guide portions **72***d* of the driver flange **72**, which are located within the internal space **72***c*. Each guide portion **72***d* is tilted backward in terms of the direction in which the drum grounding plate **71** is inserted into the drum grounding plate **71**; in other words, the bottom end of the guide portion **72***d* is located more inward of the internal space **72***c* than the top end of the guide portion **72***d*. Therefore, as the drum grounding plate **71** is further inserted, it is guided downward in the drawing by the pair of guiding portions **72***d*. As a result, the tip portion of the drum grounding plate **71**, which essentially is the contact point, is elastically deformed into the space **72***c*, and the positioning pin **72***b* of the driver flange **72**, which projects from the rear surface of the driver flange **72** fits into the positioning hole **71***d* of the drum grounding plate **71**.

The bottom end of each of the slanted guide portion **72***d* is connected to the slit (groove) **72***e*, the dimension of which in terms of the vertical direction in FIG. **8** is equal to the thickness of the drum grounding plate **71**. Thus, as the drum grounding plate **71** is further insert after its contact with the pair of guiding portions **72***d* in FIG. **8** (step **4**), the pair of projections **71***c* of the drum grounding plate **71** slide into the pair of slits (grooves) **72***e*, one for one. Even after the sliding of the pair of projections **71***c* of the drum grounding plate **71**

into the pair of slits (grooves) **72***e*, the tip portion of the drum grounding plate **71** is kept within the space **72***c* by the resiliency of the drum grounding plate **71**.

The leading end portion of the drum grounding plate **71**, in terms of the plate insertion direction, is provided with a catch portion **71***f* formed by bending the very tip of the leading end portion of the drum grounding plate **71**. Thus, as the drum grounding plate **71** is further inserted into the driver flange **72** while elastically bending the trailing end portion of the drum grounding plate **71** in the direction indicated by an arrow mark in FIG. **8** (step **4**), the catch portion **71***f* is moved beyond the flat end portion **72***g* of the driver flange **72**, and is moved downward, in the drawing, sliding on the flat end portion **72***g*, by the resiliency of the drum grounding plate **71** itself. In other words, the tip of the drum grounding plate **71** is moved downward in the space **72***c*, as shown in FIG. **8** (step **5**).

Further, the driver flange **72** is provided with a recess **72***f* into which the catch portion **71***f* of the drum grounding plate **71** latches. As the pressure applied to the rear end of the drum grounding plate **71** is removed, the resiliency of the drum grounding plate **71** generates such force that acts in the direction to move the tip of the drum grounding plate **71** in the direction indicated by an arrow mark in FIG. **8** (step **6**). As a result, the back side of the flat portion **71***a* of the drum grounding plate **71** is placed flatly in contact with the flat portion **72***g* of the driver flange **72**. It should be noted here that the dimension m (distance between the rear end and flat end portion **72***g* of the driver flange **72**) and dimension n (distance between the rear end and flat portion **71***a* of the drum ground plate **71**) are set so that even if the combination of the tolerances of the drum grounding plate **71** and river flange **72** is substantial, the equation n=m is satisfied, ensuring that the flat portion **71***a* of the drum grounding plate **71** is placed flatly in contact with the flat end portion **72***g* of the driver flange **72**.

The catch portion **71***f* located at the very tip of the drum grounding plate **71** latches into the recess **72***f* of the driver flange **72**, preventing thereby the drum grounding plate **71** from floating upward, since the catch portion **71***f* is formed by bending rearward the very tip of the drum grounding plate **71**. Therefore, it entirely fits into the recess **72***f* of the driver flange **72**, and therefore, does not interfere with the electrical connection between the drum grounding plate **71** and drive shaft **70**.

In the step 7), the positioning pin **72***b* is thermally deformed to form a retainer portion **72***h* in order to prevent the drum grounding plate **71** from moving relative to the driver flange **72**.

The above described steps 1)–7) ensure that the drum grounding plate **71** is precisely positioned in the driver flange **72**. In particular, they ensure that the aforementioned two contact points between the drive shaft **70** and drum grounding plate **71** remain stable in position.

In the step 8), or the last step, the rear end portion **72***i* of the driver flange **72** is pressed into the drum cylinder **74**. During this step, the projection **71***e* of the drum grounding plate **71** slides on the internal surface of the drum cylinder **74**. After the rear portion **72***i* of the drum grounding plate **71** is pressed into the drum cylinder **74**, the projection **71***e* is kept pressed upon the internal surface of the drum cylinder **74** by the resiliency of the drum grounding plate **71**, ensuring the electrical connection between the drum grounding plate **71** and drum cylinder **74**.

The above described steps for assembling the photosensitive drum unit **1** makes it possible to work on the driver flange **72**, from one end of the driver flange **72**, that is, the drum grounding plate **71** can be simply inserted into the driver flange **72**, from the rear end of the driver flange **72**, improving the efficiency with which the photosensitive drum unit **1** is assembled. Further, since the drum grounding plate **71** is formed as a single-piece component, and the interior of the driver flange **72** is structured as described above, not only is it ensured that the photosensitive drum unit **1** is properly grounded, but also, the photosensitive drum unit **1** is improved in assembly efficiency. In other words, according to this embodiment of the present invention, the drum unit **1** can be reliably grounded to the apparatus main assembly **100** with the use of the simpler structural arrangement, improving thereby the image forming apparatus in cost performance.

As described above, in this embodiment:

1) The photosensitive drum unit **1** is grounded through the electrical connection between the drive shaft **70** (first conductive member) on the main assembly side of the image forming apparatus, and the drum grounding plate **71** (second conductive member) placed within the drum cylinder **74** of the photosensitive drum unit **1**. In the case of this structural arrangement, the drum grounding plate **71** is provided with the flat contact portion **71***a* and arm-shaped contact portion **71***b*, and as the rotational driving force is transmitted to the spiral projection **72***a* having entered the spiral hole **73***a*, the force A' which draws the spiral projection **72***a* into the spiral I hole **73***a* (driving force transmitting rotational member **73**) is generated, causing the photosensitive drum unit **1** to be moved toward the driving force transmitting rotational member **73**. Then, as the photosensitive drum unit.**1** is moved toward the driving force transmitting rotational member **73**, the flat contact portion **71***a* of the drum grounding plate **71** comes into contact with the tip of the drive shaft **70**, and the tip of the arm-shaped portion **71***b* slides on the surface of the tip **70***a* of the drive shaft **70**. In other words, the structural arrangement in this embodiment provides two means for electrically connecting the photosensitive drum unit **1** and apparatus main assembly **100**, making it possible to better grounding the photosensitive drum unit **1**.

Further, the contact point of the photosensitive drum unit **1** and the contact point of the drive shaft **70** are prevented from keeping on rubbing each other after they are connected, making it possible for the cartridge **7** to be more reliably grounded to the apparatus main assembly **100**. Further, the drive flange **72** (drum grounding plate **71**) is solidly located with the drive shaft **70**. Therefore, the wall of the hole **72***j* of the driver flange **72**, into which the drive shaft **70** fits, and the drum grounding plate **71**, are presented from being frictionally worn.

As for the first means for electrically connecting the photosensitive drum unit **1** to the apparatus main assembly **100**, the flat contact portion **71***a* of the drum grounding plate **71** is placed, and kept, in contact with the tip **70***a* of the drive shaft **70** by the contact pressure, or the force A' generated in the direction to draw the spiral projection **72***a* of the driver flange **72** into the spiral hole **73***a* of the driving force transmitting rotational member **73** as the rotational driving force is transmitted to the spiral projection **72***a* placed in the spiral hole **73***a*. Therefore, the contact pressure applies only while the driving force is inputted, preventing the components pertinent to the electrical connection between the photosensitive drum unit **1** and apparatus main assembly **100** from being fatigued by the contact pressure. Further, the point of contact between the contact points on the photosensitive drum unit side and the contact point on the appa-

ratus main assembly side are structured so that they slightly shift in position, and once the connection is fully established, they do not shift in position while the driving force is transmitted. Therefore, the tip **70***a* of the drive shaft **70** and the flat contact portion **71***a* of the drum grounding plate **71** wipe each other at the beginning of the transmission of the driving force, and yet, the components pertinent to the electrical connection between the photosensitive drum unit **1** and apparatus main assembly **100** are not frictionally worn during the rest of the transmission of the driving force.

As for the second means for electrically connecting the photosensitive drum unit **1** to the apparatus main assembly **100**, the arm-shaped portion **71***b* of the drum grounding plate **71** slides on the surface of the tip **70***b* of the drive-shaft **70**, while being kept pressured upon the surface of the end portion **70***b* of the drive shaft **70** by the resiliency of the drum grounding plate **71**. Therefore, the point of contact between the arm-shaped portion **71***b* and tip **70***b* shifts in position only at the beginning and end of the transmission of the driving force; it does not shift in position during the rest of the driving force transmission. Therefore, the arm-shaped portion **71***b* and the tip **70***b* of the drive shaft **70** wipe each other as they become fully connected, ensuring the electrical connection between the photosensitive drum unit **1** and apparatus main assembly **100**.

2) The drum grounding plate **71** having the flat contact portion **71***a* and the arm-shaped contact portion **71***b* is formed as a single-piece component, reducing thereby the component count.

3) As the means for accurately attaching the drum grounding plate **71** to the driver flange **72**, the driver flange **72** is provided with the pair of guide portions **72***d* for guiding the drum grounding plate **71** to the predetermined position in the internal space **72***c*, whereas the drum grounding plate **71** is provided with the pair of projections **71***c* by which the drum grounding plate **71** is guided by the pair of guide portions **72***d*. Therefore, the drum grounding plate **71** can be attached to the driver flange **72** by simply pushing the drum grounding plate **71** into the driver flange **72** from the rear end of the driver flange **72**, improving the photosensitive drum unit **1** in assembly efficiency.

4) For the purpose of preventing the drum grounding plate **71** from moving after its attachment to the driver flange **72**, the drum grounding plate **71** is provided with the catch portion **71***f* bent toward the rear of the drum grounding plate **71**, whereas the driver flange **72** is provided with the recess **71***f* into which the catch portion **71***f* latches. In addition, the drum grounding plate **71** is shaped so that as the drum grounding plate **71** is attached to the driver flange **72**, the catch portion **71***f* latches into the recess **72***f* and remains latched therein, by the resiliency of the drum grounding plate **71** itself. Therefore, the actual contact portion, or the tip, of the drum grounding plate **71** is prevented from floating (becoming separated) from the driver flange **72**. Therefore, it is assured that the point of contact is precisely position. Consequently, the photosensitive drum unit **1** is better grounded.

5) The photosensitive drum unit **1** having the above described drum grounding features 1)–4) may be structured so that it can be directly mounted into, or removed from, the apparatus main assembly **1000**, without being placed in the process cartridge. Such an arrangement also produces the same effects as those described above.

[Miscellanies]

1) As for the developing method, one of the widely known developing methods, for example, two component magnetic brush based developing method, cascade developing method, touch-down developing method, cloud developing method, etc., may be employed, instead of the developing method employed in the above described embodiment.

2) In the above described embodiment, the so-called contact type charging method is employed as the charging means. Obviously, the charging method does not need to be limited to the above described one. For example, one of the charging methods, which has been widely used in the past, may be employed. Namely, a piece of tungsten wire is surrounded on three sides by a shield formed of metallic substance such as aluminum, so that the positive or negative ions generated by applying high voltage to the tungsten wire can be transferred onto the peripheral surface of the photosensitive drum in order to uniformly charge the peripheral surface of the photosensitive drum.

As for the charging means, a blade (charge blade), a pad, a block, a rod, a wire, or the like, may be employed in stead of the aforementioned roller.

3) As for the method for removing the toner remaining on the photosensitive drum, a cleaning means in the form of a blade, a fur brush, a magnetic brush, or the like, may be employed instead of the above described one.

According to the present invention, it is possible to provide an electrophotographic photosensitive drum capable of reliably establishing electrical connection between it and the main assembly of an electrophotographic image forming apparatus, a process cartridge comprising said electrophotographic photosensitive drum, and an electrophotographic image forming apparatus compatible with said electrophotographic photosensitive drum and process cartridge.

Also according to the present invention, it is possible to provide an electrophotographic photosensitive drum capable of wiping its electrically conductive member in order to be reliably grounded, a process cartridge comprising the electrophotographic photosensitive drum, and an electrophotographic image forming apparatus compatible with the electrophotographic photosensitive drum and process cartridge.

Also according to the present invention, it is possible to provide an electrophotographic photosensitive drum capable of rotating the first and second electrically conductive members together in order to prevent the conductive members from being frictionally worn, a process cartridge comprising the electrophotographic photosensitive drum, and an electrophotographic image forming apparatus compatible with the electrophotographic photosensitive drum and the process cartridge.

While the invention has been described with reference to the structures disclosed herein, it is not confined to the details set forth, and this application is intended to cover such modifications or changes as may come within the purposes of the improvements or the scope of the following claims.

This application claims priority from Japanese Patent Application No. 099503/2004 filed Mar. 30, 2004, which is hereby incorporated by reference.

What is claimed is:

1. An electrophotographic photosensitive drum usable with an electrophotographic image forming apparatus, comprising:

a non-circular twisted projection having a cross-section with a plurality of corner portions, said non-circular

twisted projection being provided at one longitudinal end of said electrophotographic photosensitive drum, and being engageable with a non-circular twisted hole having a cross-section with a plurality of corner portions, the non-circular twisted hole being disposed at a central portion of a driving rotatable member of a main assembly of the image forming apparatus; and

a drum electroconductive member provided on said projection and being electrically connected with said electrophotographic photosensitive drum, said drum electroconductive member being contactable with a main-assembly electroconductive member electrically connected with the main assembly of the image forming apparatus, the main-assembly electroconductive member being disposed in the hole to ground said electrophotographic photosensitive drum,

wherein a contact position between said drum electroconductive member and the main-assembly electroconductive member moves in interrelation with said projection being moved toward the hole by rotation of the driving rotatable member when said projection is engaged with the hole of the driving rotatable member, and

wherein said drum electroconductive member has a projected hook, and a driving side flange member of said non-circular twisted projection has a recess configured to engage said hook, to prevent movement of said drum electroconductive member, and when said drum electroconductive member is mounted to said driving side flange member, said hook and said recess are urged toward engagement with each other.

2. An electrophotographic photosensitive drum usable with an electrophotographic image forming apparatus, comprising:

a non-circular twisted projection having a cross-section with a plurality of corner portions, said non-circular twisted projection being provided at one longitudinal end of said electrophotographic photosensitive drum, and being engageable with a non-circular twisted hole having a cross-section with a plurality of corner portions, the non-circular twisted hole being disposed at a central portion of a driving rotatable member of a main assembly of the image forming apparatus; and

a drum electroconductive member provided on said projection and being electrically connected with said electrophotographic photosensitive drum, said drum electroconductive member being contactable with a main-assembly electroconductive member electrically connected with the main assembly of the image forming apparatus, the main-assembly electroconductive member being disposed in the hole to ground said electrophotographic photosensitive drum,

wherein while said projection is in engagement with the hole and is being rotated, the main-assembly electroconductive member and said drum electroconductive member are integrally rotated while being in contact with each other,

wherein said drum electroconductive member has a projected hook, and a driving side flange member of said non-circular twisted projection has a recess configured to engage said hook, to prevent movement of said drum electroconductive member, and when said drum electroconductive member is mounted to said driving side flange member, said hook and said recess are urged toward engagement with each other.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 7,003,247 B2
APPLICATION NO. : 10/960117
DATED : February 21, 2006
INVENTOR(S) : Isao Koishi et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

COLUMN 4:
Line 16, “provided a” should read --provided an--.
Line 59, “nected” should read --nected to--.

COLUMN 12:
Line 47, “can” should read --can be--.

COLUMN 16:
Line 13, “fits ,” should read --fits,--.
Line 34, “upon-the” should read --upon the--.
Line 36, “positioned-relative” should read --positioned relative--.

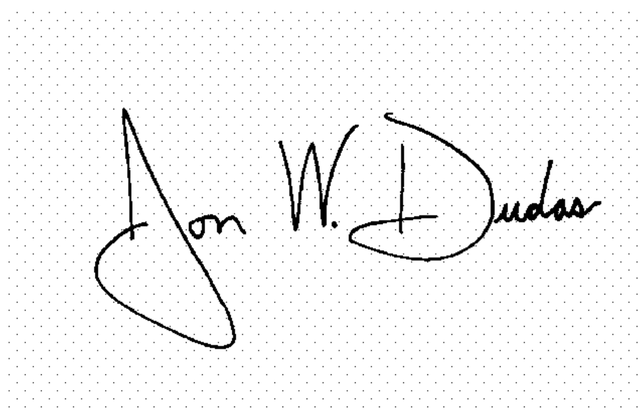
COLUMN 20:
Line 63, “insert” should read --inserted--.

COLUMN 22:
Line 32, “unit. 1” should read --unit 1--.

COLUMN 24:
Line 23, “in stead” should read --instead--.

Signed and Sealed this

Tenth Day of July, 2007



JON W. DUDAS
Director of the United States Patent and Trademark Office